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MIS managers play this counting game to legitimize their budget

Continued on page 11

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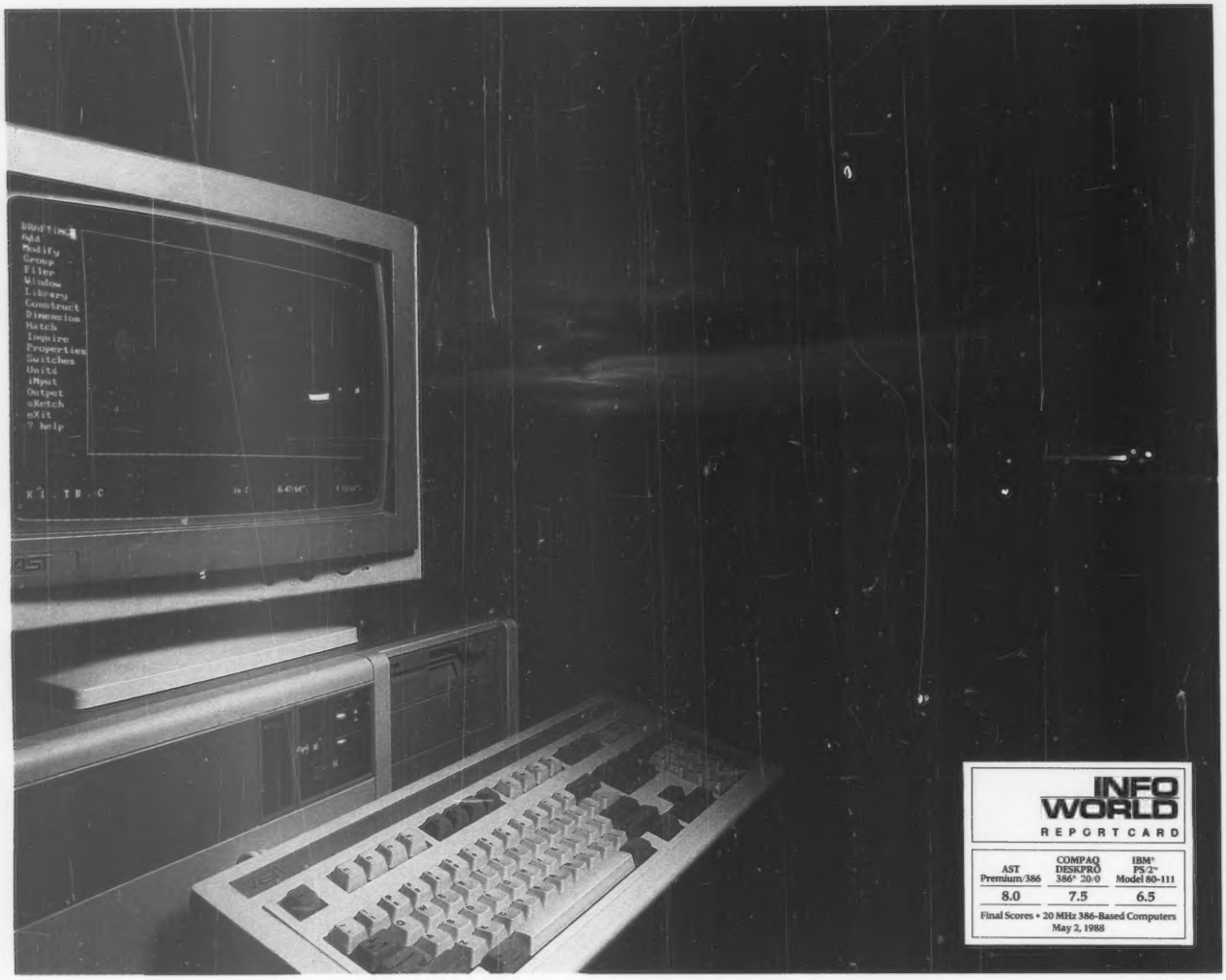

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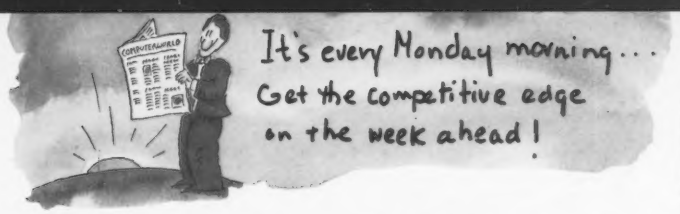

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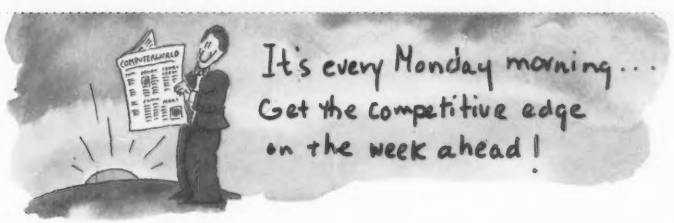

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ENTER

Productively speaking

By Naomi Karten

This decade of computing is reflected in a set of buzzwords, and they're all in the name of productivity. Few articles or speeches for an MIS audience lack the jargon, showing how savvy managers improve productivity — or at least how much they talk about it.

For those MIS professionals who want to speak the language or need to spruce up their reports to management, here is a buzzword starter kit:

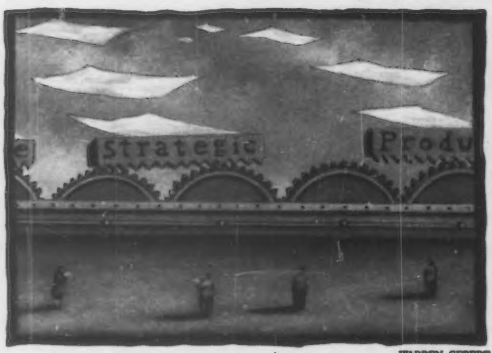
Backlog: A to-do list that gets longer with each productivity improvement. It used to be that only MIS had a backlog. Now information centers also have backlogs, in the form of users to train, hardware to install and software to evaluate.

And since so many end users now operate personal computers, they have their own backlogs. Backlog has become a handy measuring device: The longer it gets, the harder the company is trying to improve productivity.

Information technology: When mainframes reigned supreme, computer professionals called the field "data processing." When personal computers came along, DP people started losing control, so they called themselves MIS and renamed the field "information technology." This name hints at complexity and conveys that MIS is in charge of the really important stuff. Watch for programmers to be reclassified as information engineers.

Innovative: In the age of data processing, improving productivity was simply a matter of automating manual tasks. But in the age of information technology, it is important for a vendor to seek innovative solutions.

The word "innovative" means it has never been tried before, it's too complicated to implement, it's too expensive to support, and it will probably embroil the company in a look-and-feel lawsuit.



WARREN GEBERT

Leadership: This is what MIS is often told it lacks, and what it is supposed to assert in order to move successfully into the 1990s. Counts for less if the followers are out in front of the leaders.

Leverage: Leveraging your resources means that now that you've spent a fortune on productivity tools, you'd better spend another chunk on training so people will know what to do with the stuff. Can't improve productivity, after all, if the "on" switch doesn't get exercised now and then.

At budget time, when you risk losing positions that aren't filled, leverage becomes the inverse of Parkinson's Law: The number of people expands to fill the work available.

Management support: As in "I want management support." Usually what MIS means is "Give me budget, staffing, facilities, equipment, authority, influence and clout — and then get out of my way and leave me alone."

To hear MIS tell it, management support is No. 1 in importance and at the bottom of the heap in delivery.

Partnership: There's a lot of talk these days about the need for a partnership between MIS and end users. When MIS people mention this partnership, they often mean "Let's you and I agree to do it my way." This buzzword is new. When MIS absolutely ruled the whole computer roost, there was no talk of partnerships.

Proactive: Used in contrast to reactive, which means responding to users who are bombarding you with unreasonable demands. (Some in MIS consider "unreasonable demands" to be a redundant phrase.) To avoid this reactive stance, MIS professionals are being urged to become more proactive, which means doing things before anyone is interested.

At that stage, management support is nonexistent (see "management support"), there is no money in the budget, and your idea is put off until "later." Eventually, end users start asking for the project, which immediately makes you reactive.

Proliferation: A politically tainted MIS word. It means they (end users) have PCs, and we (MIS) don't like it.

Productivity: Doing things wrong faster than ever before.

Productivity gain: Being able to use the time you saved to do work that doesn't need to be done in the first place.

Productivity improvement: The ways in which things are better as a result of using a productivity tool. For example, as the ads indicate, if you implement any four productivity tools, you can cut your work load to zero or less.

Productivity tool: A tool that, if it works at all, primarily acts to create more work for the already overworked. You know it's a productivity tool if it solves some of today's problems and creates a whole new set for tomorrow.

Strategic: Often talked about with a great deal of hoopla, as in, "Now you, too, can use information as a strategic tool." If recent speeches and articles are any indication, only a handful of organizations have ever done anything strategic with information. And lately, some of these companies are being kicked in the strategic teeth and raked over the strategic coals. Strategic was definitely "in" in 1987, but be careful — it may be out by 1989.

Becoming a buzzword pro

If you really want to learn how to use these terms fluently, study the publications that cross your desk. The buzzwords are easy to find, and once you spot one of them, the rest are sure to follow.

Carefully review how these words are used by experts — experts at using them, that is. Listen attentively when you sneak off to conferences at fun-in-the-sun locations. Some speakers are buzzword pros. Back in the privacy of your office, practice using these words in context. Try saying, "Today I think I'll do something strategic."

Buzzwords can be used in combinations. "Proactive productivity" and "innovative partnership" work as well as "proactive partnership" or "innovative productivity."

Note that buzzwords can be used in numerous combinations. "Proactive productivity" and "innovative partnership" work just as well as "proactive partnership" and "innovative productivity." It doesn't much matter.

Stand in front of your mirror and say these words with a straight face. Keep trying; it's not easy.

And ignore the fact that these words are overused. No one else seems to notice.

Karten, president of Karten Associates in Randolph, Mass., is a trainer, consultant and lecturer in the management of end-user computing. She is author of *Surely You Bluff... and Other Works on End-User Computing*, published by TLI Publications.

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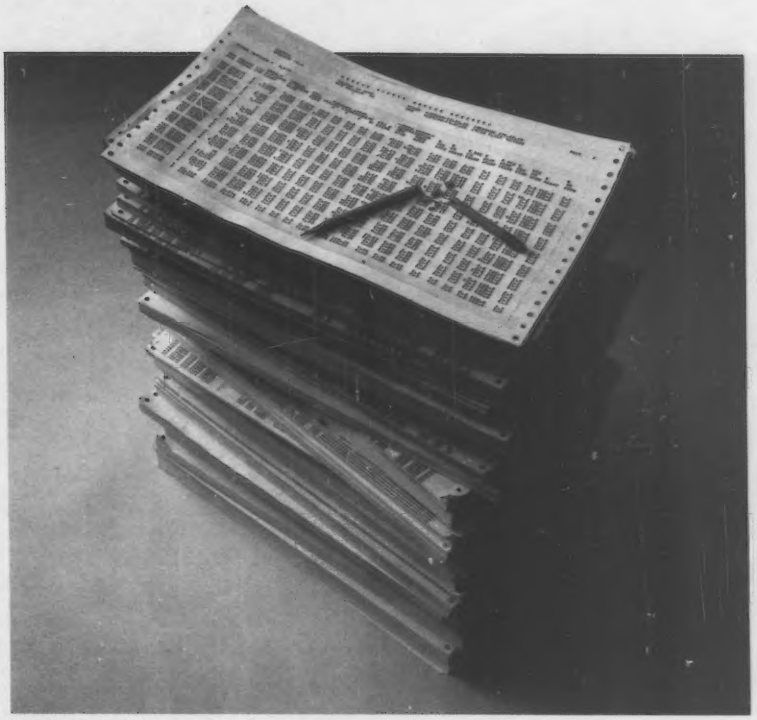

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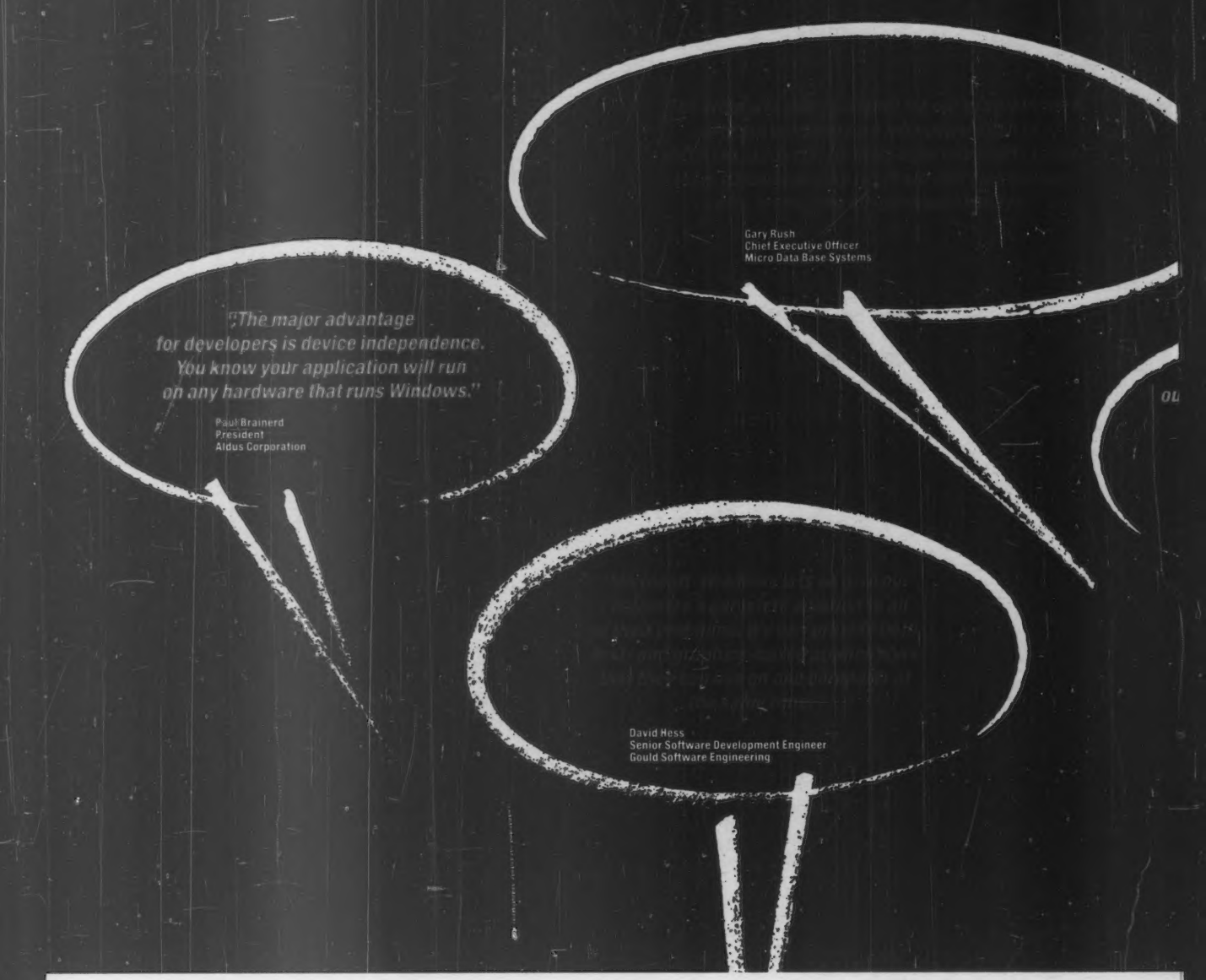

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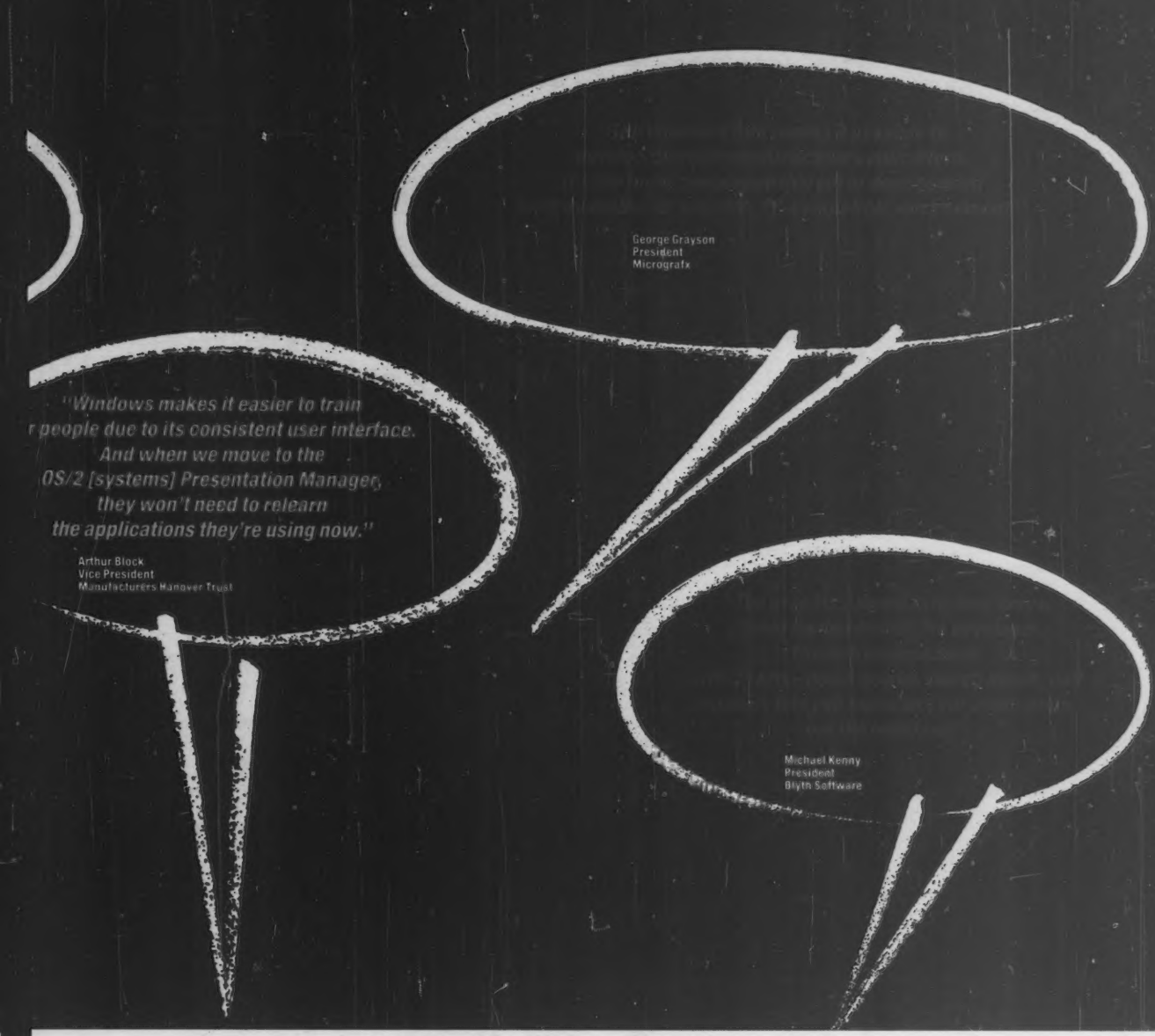

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INTERVIEW

Stephen Roach: Stop rolling the dice on technology spending

Stephen Roach, a senior economist and principal at Morgan Stanley & Co. in New York, studies the relationship between investment in information technology and productivity in various industries. His controversial conclusion: America's technology "buying binge" in the 1980s has bought no apparent productivity gains to the white-collar service sector. He was interviewed by *Computerworld Extra* Editor George Harrar.

You found that service-sector businesses spent 2½ times as much on information technology in the mid-1980s as in 1970. What was the effect on productivity?

Productivity growth in the service sector has averaged about a half a point per year in the present decade. That compares with about 4% average gains that we're now seeing in manufacturing over the last five years.

Can you quantify the investment in dollars?

For the first quarter of this year, business at large was spending at about a $160 billion annual rate in constant 1982 dollars. Of that amount, the service sector is probably spending about $120 billion, roughly 80% of the total.

If this huge investment is not bringing measurable gains in productivity, why are so many service-sector businesses still spending so heavily?

That's the $64,000 question here. We don't have a precise answer. There is the presumption that technology is good for business; that technology which can enhance computational speed is a necessity to compete in an increasingly cost-conscious and highly competitive global marketplace.

Do you dispute that presumption?

I dispute the idea that we need ever-increasing computational power to get work done by white-collar workers in our service sector. I think the myth of computational efficiency does not satisfy productivity criteria for companies or the economy at large.

American business managers are hooked on technology. Machines that appear to be compact, that historically fit in with technology acquisition, tend to be addictive.

In addition, there are a lot of hidden costs that ultimately impede productivity but are not fully assessed when the technology expenditure is initially considered. Here I am talking about MIS staffs, incompatible systems across division lines and information overload as it begins to overwhelm many corporate and managerial structures.

YVONNE HEMSLEY

Is MIS hiding some of the costs, or are they just not being measured?

A lot of it is a measurement problem. We simply do not have internal counting systems that allow us to fully cost out all of the expenses associated with running information technology. MIS is part of that problem.

Can you give an example of information overload?

In my own area — the finance services industry — we have an infinite stream of information produced by our computers and telecommunications equipment. Thousands and thousands of pages of electronic news are available at any given moment. Salesmen, traders, analysts, managers don't know where to turn when they are faced with this overwhelming onslaught of electronic information.

Would you be able to do your analysis of this information problem without relying on what you describe as an overwhelming information stream?

Look, information technology is essential, it's just a question of degree. I think we have over-MIP'd ourselves.

Why are chief executive officers, who generally have not grown up in technical areas and don't have any inherent bias toward computerization, standing for such spending if MIS cannot prove to them productivity gains?

I don't think they are, which is why high-tech demand in America over the last three years has really gone through a major shakeout. We have had a recession in computer and related industries vis-a-vis historical performance, and part of that is due to the productivity disappointments that are now becoming apparent to CEOs.

Second, I would simply point out that many managers are a function of the corporate structure that they inherit. When a manager comes into a company that has historically built ever-larger portions of its capital outlays dedicated toward the acquisition of information technology, it's hard to turn that around overnight. The inertia of those purchases becomes self-perpetuating, especially since the technology cycle has immediate obsolescence.

In the latest quarter, IBM showed strong sales of mainframes. The company is still selling large-MIPS machines.

That comes after how many quarters — a year and a half — of extreme disappointment? IBM, as its stock price indicates, has really suffered a significant deterioration in the whole tone of its business.

I would be very cautious in saying that the first-quarter results mean there is still a strong underlying demand for technology. It's an improvement, to be sure, an encouraging one at that, but leaves the company well below historical growth trends.

Should we really be talking about productivity as the main justification for spending on computers and office machinery, or should we be looking at some other values — such as strategic or competitive performance — to justify investment?

Productivity to me from the standpoint of the overall macroeconomy is the ultimate benchmark by which we can gauge the success of any investment, whether high-tech or low-tech, white-collar or blue-collar. I am the first to admit it is very difficult to measure productivity, especially for industries that produce services rather than product goods.

All that implies to me — and I'm certainly not taking this need lightly — is that we certainly have to place emphasis on better measuring productivity in the service-producing economy. Ultimately, if we fail to judge high technology against some semblance of productivity criteria, then we stand the potential of misplacing a lot of resources in our economy.

And you think we have already done that?
I think it has been an important reason behind the productivity disappointments of the present decade for the U.S. economy.

You have written that money spent on information systems is money that, for example, service-sector companies might not be spending on such things as buildings. Is money being diverted from other essential areas of the budget to information systems?
I don't know that for certain. It's hard to look at our numbers and say that if information technology was a smaller slice of the capital budget, that would free up funds that might go elsewhere.

We do know that as of early this year, information technology products accounted for about 42% of corporate America's total outlays on capital equipment — 42%. That's the single largest line item in the capital spending budgets for the economy at large as of the first quarter. That's for manufacturing and services combined — nongovernment.

But isn't a large part of that figure for communications? Separate out the telephone system, for instance.
About 25% is computers and office machinery; 10.5% is communications. The balance is photocopiers, scientific instruments and the like. So easily 60% of the information processing outlay goes for computers and computational pieces of office equipment.

Is the investment disappointing on the communications side?
There's no way I can pin the productivity disappointment on a specific type of investment. I simply point out the following: The productivity disappointments that we have seen as a country have been concentrated in that segment of the economy that has two very important characteristics. One, two thirds of jobs are in the white-collar occupational categories; and two, the bulk of capital stock is held in the form of information technology items.

What we conclude is that white-collar workers are not making effective use of information technology to generate the productivity gains that are required to improve the economy's standard of living.

Whether it's due to telecommuncations equipment or computers . . . my conclusion is that because computers are the much larger component, that's where the blame lies. However, I can't say how much is due to what piece.

Instead of focusing on productivity, why not look at the bottom-line profitability of a company or industry?
Over time, profitability and productivity do move hand in hand. Profitability is certainly an acceptable alternative.

Have you done the correlations between spending on information technology and profitability?
The service sector in some areas has done quite well in profitability, but in general has been very disappointing this decade. Over the decade, roughly two-thirds of the profitability increase we can impute to manufacturing and financial industries, which largely benefit from interest rate swings. The service sector has shown steady increase in profitability but is not the driving force behind the earnings growth of the present decade.

What industries are spending the most for computers and office machinery?
The finance sector is clearly spending a disproportionate share of its outlays on computers. Finance/insurance accounted for about 35% of total business outlays in 1985 — $46 billion. In 1986, the figure increased to 43%.

And are they concurrently getting the least in return?
The answer has to be yes. The productivity disappointments have been very acute, and this is the industry that has dramatically increased its reliance on technology over this period.

How about other industries?
The service sector in the narrow sense, which would include business and personal services, hotels, health care, recreation, accounts for about 12% of spending on computers and related technology. That's an area that has had a disappointing experience with respect to productivity growth over the last seven or eight years.

Continued on following page

COMPUTER AND OFFICE MACHINERY EXPENDITURES
Percent of total capital spent in U.S., by industry*

Business Sector	1950s	1960s	1970s	1986
Goods producing	45%	38.2%	35.1%	23.4%
Service providing	**55**	**61.8**	**64.9**	**76.6**
Transportation	9.6	6.8	3.5	1.2
Rail	1.6	1	0.4	0.1
Nonrail	8	5.8	3.1	1.1
Air	1.7	1.4	0.9	0.4
Trucking	1.7	1.7	0.3	0.1
Other	4.6	2.8	1.9	0.6
Communications	2.6	2.5	1.9	1.2
Telephone/telegraph	2.1	1.7	1.7	1
Broadcasting	0.5	0.8	0.2	0.1
Public utilities	1.8	1.7	0.8	1.1
Electric	1	0.9	0.2	0.2
Gas/other	0.8	0.9	0.6	0.9
Trade	10.3	12.3	14.2	17.1
Wholesale	6.2	8.2	11.9	15.7
Retail	4.1	4.1	2.3	1.4
Finance/insurance/real estate	19.3	23.8	29.9	44.3
Finance/insurance	16.1	19.9	26.5	43
Banks (includes Federal Reserve)	3.4	5.4	9.7	16.7
Credit agencies	2.7	4.1	6.3	8.3
Securities brokers	0.3	0.6	1	1.7
Insurance carriers	3.4	3.7	4.6	11.9
Insurance agents	3.7	4.2	1.9	0.6
Investment holding companies	2.6	2	3.1	4
Real estate	3.2	3.9	3.3	1.3
Services	11.5	14.6	14.6	11.7
Hotels/lodging	0.2	0.4	0.4	0.6
Personal	0.3	0.4	0.2	0.1
Business	3.9	5.9	8.6	7.1
Auto repair	1	1.1	0.4	0.5
Miscellaneous repair	0.1	0.2	0.2	0.1
Motion pictures	0.2	0.2	0.2	0.3
Amusement/recreation	0.6	0.5	0.3	0.4
Health	1.1	1.1	0.8	0.6
Legal	0.8	1.4	1.2	0.6
Educational	1.6	1.8	1.1	0.5
Other	1.7	1.6	1.2	0.8

* Figures are rounded averages over designated intervals derived from U.S. Department of Commerce data

INFORMATION PROVIDED BY MORGAN STANLEY & CO.
CW CHART

COMMENT

John Young
President and CEO
Hewlett-Packard Co.

Competitiveness has, surprisingly, become somewhat of a buzzword in public- and private-sector circles alike. It is the ability of a nation or a firm to produce goods and services that can win in the international marketplace and at the same time earn high wages.

By that definition, the U.S. shows a declining ability to compete, because real wages today are lower than they were a decade ago.

Government and industry share the responsibility for competitiveness. With its oversight of trade, fiscal and monetary policies, the government creates the environment within which industry competes. But government can't legislate success in world markets, so industry does the real competing.

What should the private sector put on its own competitiveness agenda? My studies and conversations with business leaders convince me that using information more effectively is perhaps the single most important source of competitive differentiation that companies can and should develop.

During the past decade, businesses have applied technology on the factory floor and in the office. Results, however, have been mixed.

Automation of the factory floor can drive up output and push down costs while improving quality. The results are real and tangible, and business leaders can see a rapid return on investment.

Parallel success in the office — or at least tangible evidence of that success — has been more elusive. In fact, according to research done by Morgan Stanley Group, Inc., white-collar worker productivity has declined about 7% during the past decade, compared with a 17% increase in production worker productivity.

Hewlett-Packard's results are better — 5% and 17% growth in productivity for white-collar and production work forces, respectively. However, our results show a similar disparity between office and production environments.

These results raise serious questions about the billions of dollars that businesses, government and other enterprises invest in information resources, presumably to improve white-collar productivity: What's standing in the way of our progress?

I believe the answer falls into two categories: technical and management barriers.

Today, many progressive computer companies are committed to addressing technical barriers in many ways:

- By adopting industry standards for operating systems, languages and data base access technologies in order to foster multivendor environments as an alternative to incompatible proprietary environments.
- By creating peer-to-peer networks based on Open Systems Interconnect standards as an alternative to hierarchical proprietary networks that can impede organizational teamwork and create overhead inefficiencies.
- By providing an intuitive, easy-to-learn user interface that is consistent across applications, allows easy and frequent switching between different applications and can provide access to information across the enterprise.

While computer manufacturers overcome these technical barriers — and they are falling rapidly — companies that use information systems must solve the managerial barriers that can be found in many enterprises.

Information systems managers often view success as the implementation of an application. Operations managers, on the other hand, measure how information systems contribute to the implementation of strategy, increases in revenue and improvements in productivity. Informations systems and operations managers must view goals and measure success the same way.

Management must take responsibility for developing a common view of how to respond to competitive challenges and for determining the role that information systems will play in those responses.

ILLUSTRATION BY JUSTIN NOVAK

Continued from preceding page

You call productivity paybacks in many instances "a shot in the dark." And therefore the problem falls squarely in the laps of U.S. managers.

Yes, because the way the process works, the technology acquisition has been made first and the productivity evaluation is made second.

Isn't that just because it's very difficult to understand the possible productivity benefits?

Yes, but you might wonder — even though it's difficult to understand — is that really a wise strategy to follow here, of getting the equipment because you feel competitive pressures, and then trying to justify it on the basis of performance? I would think business managers might be more concerned about evaluating their needs from the standpoint of productivity as well as internal organizational requirements and then trying to purchase the machinery that is compatible with those objectives.

I would also add that that's where the replacement cycle can get in the way, because it's not clear to me that you must meet those productivity needs by updating your stock of technology with the latest model as it comes off the assembly line.

"If you're going to justify technology as something you got to have because if you don't, you may miss something — that's where you're getting into trouble."

Some information systems executives are trying to create an enabling environment, saying that information systems can't foresee how computers will be used in many cases by end users, that some of the best uses will come by seeding the company with systems. In this case, there is no way to measure beforehand the productivity, no way even to foresee the use.

That's what I mean by rolling the dice. If you're going to justify technology as something you got to have because if you don't have it, there's a chance you may miss something — that's where you're getting into trouble.

I stress the point I made earlier: Information technology is now 42% of corporate America's budget on total capital equipment.

There's got to be more to capital accumulation than just taking a chance on missed opportunities. That is a reality that is starting to question the wisdom of open-ended technology acquisition. It's a very expensive endeavor. It was one thing when the outlays were 15% to 20% of the total, as they were a decade ago. But when it's 42% and climbing near half of industry's total capital expenditures, that's when you have to question the wisdom of that strategy for the economy at large.

What can MIS managers do to be proactive here?

There's a lot they can do. To a large extent, the hidden MIS costs are now coming out of the closet. Corporate managers are starting to become highly sensitized to that fact that MIS is that portion of the iceberg that is right below the surface here, and that the hardware is just the tip of the iceberg.

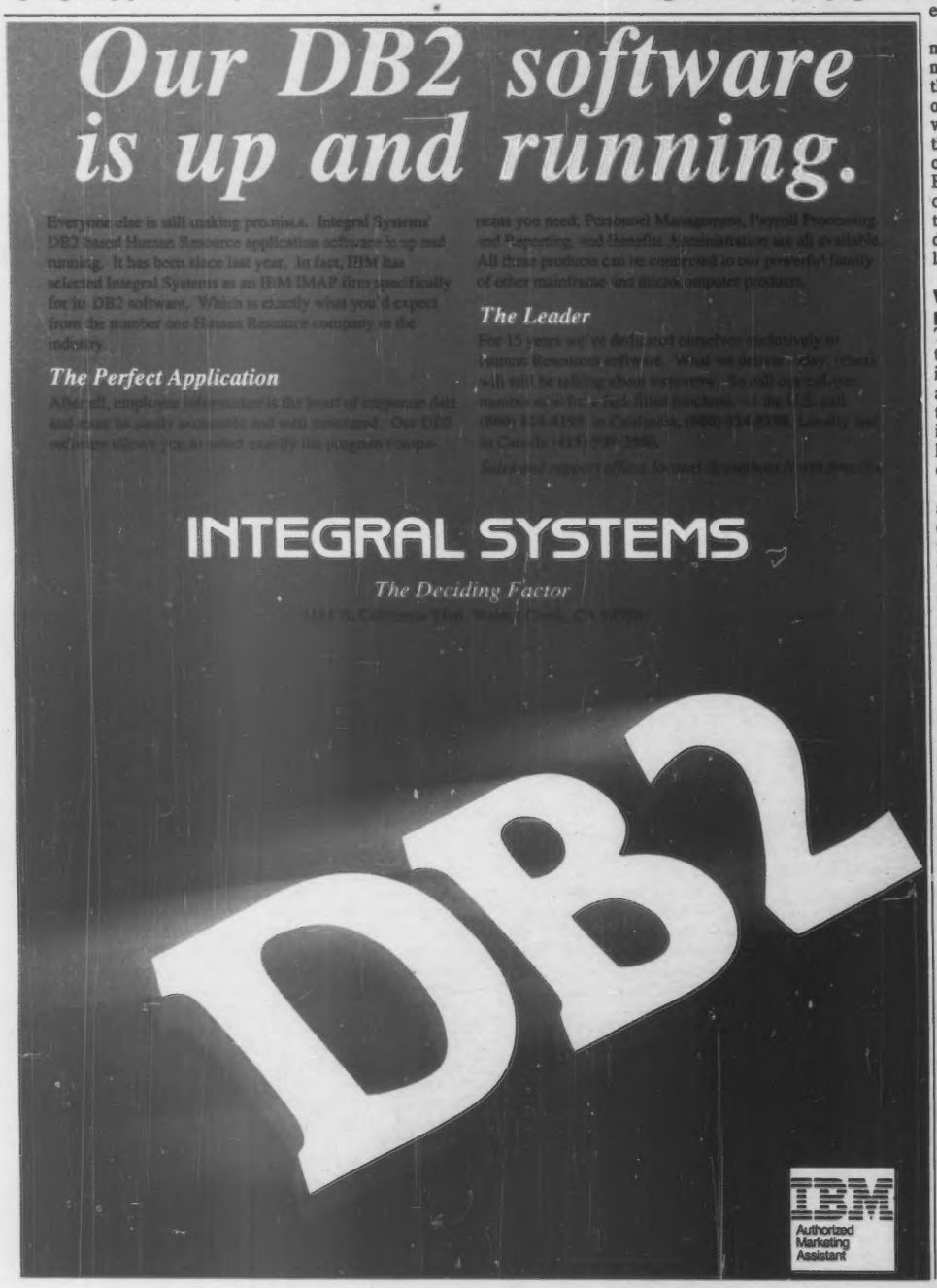
MIS can make a real effort to deal with architectural incompatibilities between different systems with a company, which is a very common problem, and get a handle on the information overload aspect of the output of this information technology. Finally, MIS managers can do their best to keep their costs in line with computational needs and labor costs. The labor cost of MIS staffs is enormous relative to the hardware cost.

Switching to the manufacturing sector, I assume you would say companies here are spending on information systems more in proportion to other expenditures and getting more value out of it. Why do you think that's the case — because machines exist in time and space, where their performance can be seen more easily?

Manufacturing has a tradition of predicating planning and budgeting in a way that is compatible with the production of a tangible good. Most business managers came out of the business schools of the 1950s and '60s, which taught them a lot about productivity management on the factory floor.

The problem is that service managers have come out of the same environment, which was largely a manufacturing heritage. The problem we are finding is that many business managers are treating their service-based enterprises similarly to factory-sector companies. But the productivity-based management system does not translate easily into a company that is employing white-collar workers to make

Continued on page 10



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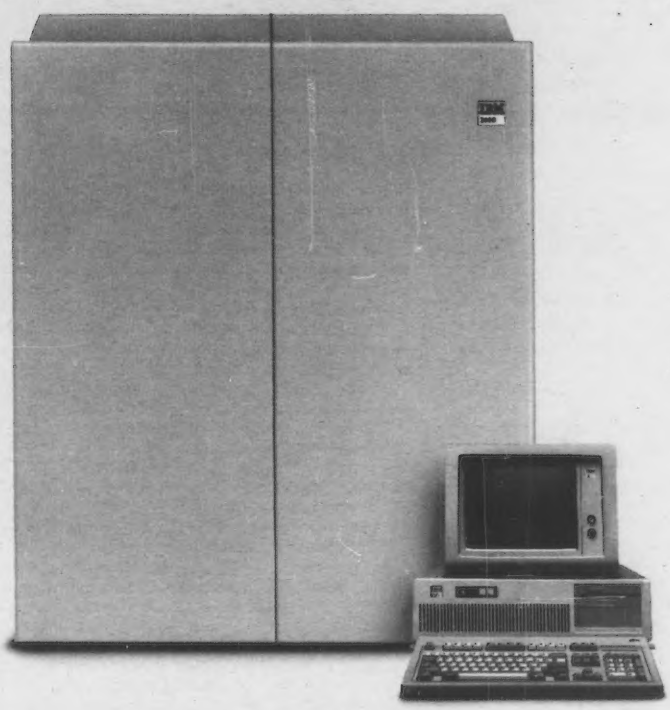

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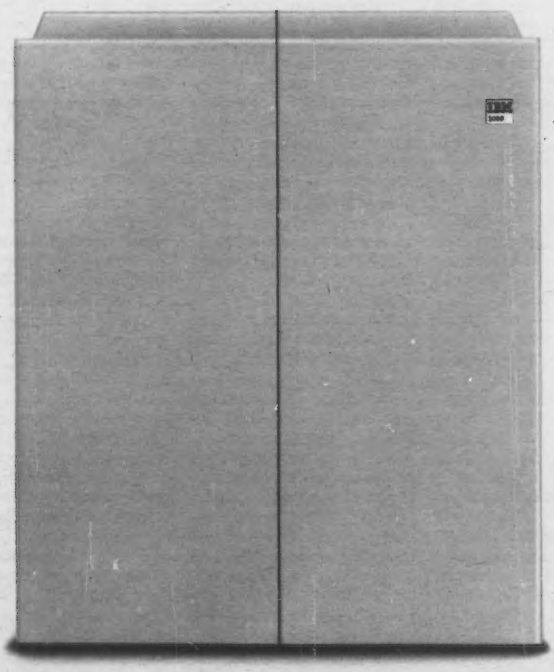

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Continued from page 8

an intangible product called services.

So manufacturing is doing better in part because managers are better at managing the use of computers there?

We've been far more selective in technology acquisition.

But the manufacturing productivity paybacks have come from hard, old-fashioned ways of cost-cutting — closing inefficient plants, reducing work forces. The computer has been a marginal or secondary player in that practice.

How have computer and communications vendors reacted to your findings?

They don't like them at all — it's a threat to the justification of the product as an essential ingredient in the growth of their industry. I can certainly understand the displeasure with these findings, but I think it should be viewed as a challenge to make information technology work, not as someone who is critical of the product itself.

> **"Productivity paybacks have come from hard, old-fashioned cost cutting."**

You do not dispute that information technology is essential to the functioning of a corporation?

I think history will judge the Information Age as being a period of structural change comparable to the Industrial Revolution, the advent of the factory assembly line, the development of a nationwide railroad system. It will go down as a singular event in the economic history of the United States.

But just as in all of those earlier periods, the U.S. economy has to make an effort to understand, digest and learn to work with a new technological breakthrough. We cannot take for granted that computers, telecommunications equipment and other high-tech machinery will automatically give us a payback. We have to work very hard to understand the technology and better incorporate it into the work effort of the U.S. economy.

If information technology is by far the largest part of capital expenditures in the service sector, and if the service sector is the largest part of the U.S. economy, and we know the economy is suffering from a tremendous productivity problem right now, is information technology — specifically computers and office machinery — the major problem with American productivity and the economy?

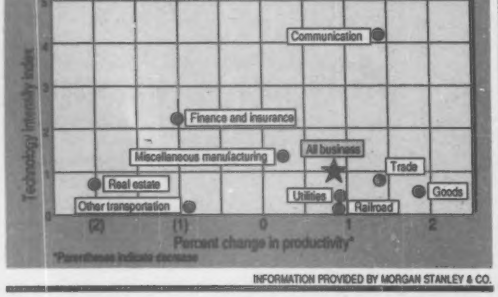
The key players in the U.S. economy, whether it's policy makers or business leaders, have made a major bet that an information-based service economy is in fact the essence of the economic growth and prosperity in the latter part of this century and probably well into the 21st century.

To the extent that information technology is the single most important tool at the disposal of the workers in this segment of the economy, that is where the pressure will be to realize ever greater gains in productivity, profitability and income-generating prosperity for the economy at large. That's the only answer.

We're well ahead of our major industrial competitors in shifting to a service-based information technology economy. Yet we're also lagging the pack in terms of productivity gains. That's not meant as an indictment of computers and information technology. It's saying that this is the stuff that is the key to our next competitive challenge. That's why I say it's appropriate to characterize the productivity problems in the service sector as America's real or hidden competitive challenge.

TECHNOLOGY INTENSITY AND PRODUCTIVITY

For the years 1979 to 1986, there is no discernible relationship between an industry's technology intensity and total factor productivity growth



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COMMENT

Jim Manzi
President, Lotus Development Corp.

White-collar productivity is under fire these days, and the personal computer is bearing the brunt of the criticism.

Corporations are questioning their multimillion dollar investment in computer technology — including 15 million PCs, hundreds of thousands of which made it onto the desk tops of professional workers without going through the corporate appropriations cycle.

Business publications, Wall Street economists and industry watchers — whom I dub the Productivity Police — fuel these concerns, asking, "Where's the beef?"

While the PC industry definitely needs to come up with sound illustrations of improved white-collar productivity, I wonder sometimes how outputs like leadership, motivation, teamwork or the birth of new ideas can be measured.

These are the intended goals of white-collar productivity — not the ability to generate more information, better and faster. The goals are to use strategically the masses of information available today, to make better decisions and to think.

Improved white-collar productivity — what we call "the New Productivity" — will be realized by those companies that take their PC investments beyond people and process automation. New Productivity companies look for ways to use technology to restructure current business processes and, ultimately, to transform their businesses. Their PC investments are driven by a strategic business vision, not by a technology vision. Here is where return on investment soars.

In a study we undertook last spring with 13 of our largest customers and the management consulting firm of Nolan Norton & Co., we learned some of the steps firms are taking toward the New Productivity.

The PC revolution, by putting raw processing power and analytical tools into the hands of individual workers, was a start. It created a nation of workers whose power and performance were boosted by their ability to access and use information.

Today, the needs of these highly computer-literate end users, coupled with corporate pressures, are driving the evolution of the PC software industry by demanding products that serve identified purposes and enhance decision making. Technology for technology's sake is no longer accepted.

Categories of products that address these demands include software tools, as opposed to "solutions"; applications that act as integrators; compact disk/read-only memory (CD-ROM) technology; and work group computing.

The traditional PC-user relationship consisted of the PC application sitting between DOS and the peripherals and the user. The new software environment puts the operating system in the basement with a multistory building of tools on top — including commercial software for compound documents, which integrates text, graphics and data seamlessly; user interface tools; applications; and various development languages.

PC applications will also increasingly be asked to serve as integrators in multivendor environments — preserving existing investments by means of forward and backward compatibility, software bridges from one platform to another and familiar user interfaces. Portability, connectivity, usability and extensibility are the key criteria for the new generation of PC applications.

Meaningful access

The New Productivity — adding value to transform data into information, knowledge and, finally, strategic decisions — will be enhanced by applications that connect resources, data and people. Examples are powerful data base servers and front ends that give meaningful access to corporate data bases.

CD-ROM technology will also make a profound impact on the New Productivity. A logical extension of the trend toward concentrating more data on compact media, CD-ROMs bring more global information directly to the end user. To gauge the growth in CD-ROMs, look at electronic data base publishing, whose 1986 industry-wide revenue of $4.5 billion will swell to more than $11.2 billion by 1991 — a compound annual growth rate of 20%, according to "Electronic Information Industry Forecast/North America, 1986-1991."

The real benefit of CD-ROM will lie in applications software that can add value and meaning to the information. For example, commercial data bases coupled with analytic software on CD-ROMs could allow trend information to be drawn directly into a customized spreadsheet program, so that users could compare corporate performance against industry norms.

Think again

The bottom line of the New Productivity is a company's ability to capitalize on a good idea or strategic vision technology makes possible. Real productivity will accrue to firms that organize to take advantage of technology's strategic benefits. For most companies, that means a fundamental change in the way they function.

Work group computing is an important outgrowth of this change. Today's information-based companies are evolving into organizations peopled by true knowledge workers — that is, workers whose level of specialization is so high that they no longer require layers of middle managers.

In these organizations, information is likely to be shared more laterally and decisions are likely to be made by task-focused teams, which work synchronously, rather than sequentially. A global economy and better communications hardware mean that such work groups stretch across disciplines, departments, divisions and time zones.

At Lotus, we recently previewed our first tool designed for work groups. Notes will allow groups to share text and graphics, to convene a meeting and to maintain centrally accessible records of events and source materials related to a project. It will make it easier for people to capture ideas, analyze information, communicate decisions, present results and share resources.

As heretical as it may sound, the New Productivity will result from people spending less time in front of their computers and more time thinking. PC applications that can free time for creative thought will deliver real productivity and profoundly affect the way the world does business.

ILLUSTRATION BY JUSTIN NOVAK

Productivity

By Paul Strassmann

Continued from cover

increases. After all, everyone — from the president down to local businessmen — suggests that we suffer from a national productivity problem that must be solved, preferably through advanced computer technology.

The generally accepted definition of productivity is the ratio of output to input. It is usually expressed in terms such as tons per employee, checks per hour, pages per secretary or revenue per salesman. If these measures can be directly attributed to profits — as is the case with most direct costs — then the conventional approach to productivity gives useful results. But I estimate that less than 35% of wages and salaries in the U.S. can account for their productivity in this way.

What about the other 65%? One cannot define productivity for most professional activities — meetings, consultations, accounting, programming or research — by applying the quantity-based I/O ratio.

- Automating the production of useless manuals cannot be counted as a productivity gain, even though numerical calculations can "prove" it.
- More lines of code do not necessarily result in useful code.
- Speeding up committee meetings or doubling their frequency avoids the question, Why are the meetings taking place at all?

Productivity gains from generic managerial applications such as electronic mail cannot be detected by any known industrial engineering method. For activities requiring professional know-how, I propose using measures that embody both value and risk as the indicators of merit.

Tall tales

I keep a bulging file of productivity claims that seek to justify the purchase of information technology. For example, one large federal agency based its purchase of personal computers on the fact that the PCs would cut back by 50% the time required for acknowledging people's inquiries. With the new equipment, the agency achieved its target response time of 10 days.

What the numbers did not reveal was the steady deterioration in how long it took to actually resolve the problems for which the inquiries were made. Problem resolution was the responsibility of a different section. The cost-benefit analysis only reported the speed with which standard computer-generated acknowledgments could be mailed out. Furthermore, the rapid initial responses actually increased taxpayer dissatisfaction — they intensified people's anticipation of a response to their questions.

Then there is the case of the high-technology division of a reputable computer-aided design (CAD) firm. The company managed to reduce drafting manpower just enough to offset the considerable costs of CAD workstations. It then claimed 68% productivity gains, based on the engineers' ability to produce a much larger number of engineering change orders with a shorter lead time and with higher quality, as rated by the engineers.

What the numbers did not show was a simultaneous downturn in the firm's profitability. Poor results were attributable to a change in competitive conditions that now called for a much smaller number of change orders. The costly and highly promoted CAD investment could not deliver expected gains.

There is a computer manufacturer that trains its sales force to make presentations to customers on how to calculate the productivity of any data center. The customer is advised to count as savings the cost of people not hired to do the job using pencils, handheld calculators and paper. These synthetic gains are obtained using an elaborate spreadsheet program, which usually yields more than 1,000% gains.

Not the point

On many occasions, I have reviewed budget proposals calling for a customary 15% annual cost increase in information technology expenses, even though profits were down five years in a row.

The increase is touted as a good deal, since it already reflects the benefits of a 20% productivity gain from lower computer prices as measured in thousands of dollars per MIPS. But the real issue is how to increase profits, not how to lower data center costs.

What these stories share is an almost universal tendency of organizations to apply measures of productivity that fit the narrow scope defined by the budget.

In large, multilayer, hierarchical organizations, the most important event of the year is budget time. The budget of production people — in other words, direct costs — flexes with revenue. Their productivity can be evaluated within the narrow confines of a production unit.

But knowledge-based work is different. It is funded as a fixed cost. Each unit must pass through the budgetary inquisition and defend its claims for scarce funds. Personnel asks for its share, and so do the legal, government liaison, accounting and systems planning departments.

This process imposes on everyone a compulsion to generate productivity indicators, regardless of whether these notches bear any relation to the value added to the organization.

No wonder thoughtful managers despair about playing this annual charade — they come to realize that knowledge work is a systematic phenomenon that cannot be isolated in the same way as stamping out gaskets or drilling holes.

Put it into context

The effects of useful professional work remain largely outside of artificially constructed intra-organizational charters. Even a small malfunction in a department such as market research, legal or planning may bring catastrophe to the cash flow of an entire institution. The value of knowledge work must therefore be observed and measured first in the context of how the whole enterprise performs.

You can discover whether knowledge-based work is productive or not if you measure the overall results delivered by the entire management team. Individual contributions make sense only if you can connect them to the overall effectiveness of information handling — which is my definition of what management and management information systems are all about.

The health of the organization is like the health of the body. Highly productive kidneys don't amount to much during a heart attack.

Like magic

At present, measuring overall organizational performance usually boils down to return on assets or related ratios, such as return on investment and return on equity.

These ratios measure the productivity of capital. But how efficiently you use capital no longer determines the success of a knowledge-based organization. Superior management is the magic element that separates excellence from mediocrity.

The productivity of management should be measured directly, not by a poor surrogate such as its capital-use proxies. I therefore advocate the concept of return on management.

Just as return on assets is cal-

Continued on following page

Strassmann consults on justification, budgeting and planning methods for profitable investment in information technology. He is retired as chief information systems executive at Xerox Corp. and is based in New Canaan, Conn.

USER VIEW

Raymond Perry
Vice-President of MIS
Avon Products, Inc.

Productivity is a wonderful word. It calls for all the best that management and technical people can create. Everyone is in favor of it, and as a national goal, it is right up there with motherhood and apple pie.

Unfortunately, unlike motherhood and apple pie, it is very difficult to recognize or create.

Generally, we think of productivity as generating a known output or product while reducing the input or resource expenditure. Although this is a comfortable way to view the equation, the definition is difficult to use for two main reasons.

First of all, while we commonly choose dollars, man-hours or some other easily defined measure of input, the measurement of output presents a problem. If output is expressed in constant units, we can understand the productivity improvement as we reduce the resource input.

However, new technology typically creates a dramatically different output. For example, a computer supported order-entry system doesn't just take orders faster and at less expense. It also allows the customer to immediately know that the item requested is out of stock and allows an alternative to be selected. The added function is difficult to quantify and measure when we ask how much the output has increased.

Second, companies seldom care just about making the same product with fewer resources. What they really want is new, expanded, different and more valuable products for the same or marginally greater resource expenditures.

To put it another way, sometimes being the low-cost producer — the result of the same output for reduced input — isn't enough. What really provides corporate growth and sells the chief executive officer is new product function.

In information systems, we deliver productivity primarily by delivering new business functions to other departments in the organization.

At Avon, we have been working on a way to identify our customers by name and address so we can more closely track their needs and be sure they continue to receive our products whenever a representative moves to a new territory.

Although there is a cost to maintain and track each of these customers, the productivity is clear in terms of improved service to our customers and increased business for the company.

Any actual measured productivity gained through technology is difficult to specify. The classical measures — such as sales per employee or time to handle a customer order — fall short of effective measurement because they fail to assess the full value of the output.

For example, in the order entry case cited above, the customer is more satisfied receiving an alternative product than an apology for an out-of-stock item.

This greater customer satisfaction, however, has been achieved at the expense of an increase in the time needed to handle the customer's order.

In examining how the information systems contribution is viewed in most information organizations, the two key measures of performance are service and impact.

Service means keeping systems operating correctly and effectively. If the computer doesn't run or the invoices aren't correct, the information organization becomes a target of frustration and anger.

When service is provided to the expected level, the organization can then serve as an agent of change and begin to improve the way the business operates.

Productivity is relevant to the information systems organization because business improvements must be linked to the technology investments and must be tracked with a positive return. At Avon, we review this step each quarter and make new investment decisions based within this perspective.

The continuing challenge for the information systems executive will be to define the impact of technology and show how the resulting changes positively affect business productivity and performance.

Continued from preceding page

culated by dividing the residual value by assets, so return on management can be derived by dividing the residual value attributable to management (that is, what is left after everyone has been paid) by the total costs of management, including secretaries, headquarters buildings, bonuses, entertainment and, yes, personal computers.

The simplicity of this method places inescapable limits on individual productivity claims, since the total of each productivity contribution can never exceed the aggregate. In this way, return on management can distinguish productivity enhancers from productivity detractors.

Risk of knowledge work

There are snake bites and there are insect bites. You better know the difference.

All information-rich professional work carries high levels of risk. Information work is a gamble because it is so easy to overlook the unexpected coming from an unanticipated direction. Manufacturing is much more predictable, since it usually consists of tangible situations that are confined in time, in space and in use.

Computers have not reduced the risks inherent in knowledge work. One can easily argue that rapidly evolving information technology further destabilized the jobs of information workers, who already represent 57% of the U.S. work force.

Therefore, one cannot speak about measuring the productivity of information work without also giving weight to its risks. One should, for example, consider a less perilous medium-gain productivity enhancement, instead of an extravagantly venturesome one offering enormous gains.

But how does one discriminate between lesser gains and extravagant expectations whose payoffs are either medium or enormous?

Perhaps the best way to illustrate this proposition is to recall the 1972 flight of an Eastern Airlines L-1011, which crashed in Florida, killing 100 people. When a light that indicates whether the landing gear is down didn't illuminate, all three pilots in the cockpit became engrossed in solving the problem (a "critical success factor," therefore one must pay attention to it). It turned out to be a faulty light bulb.

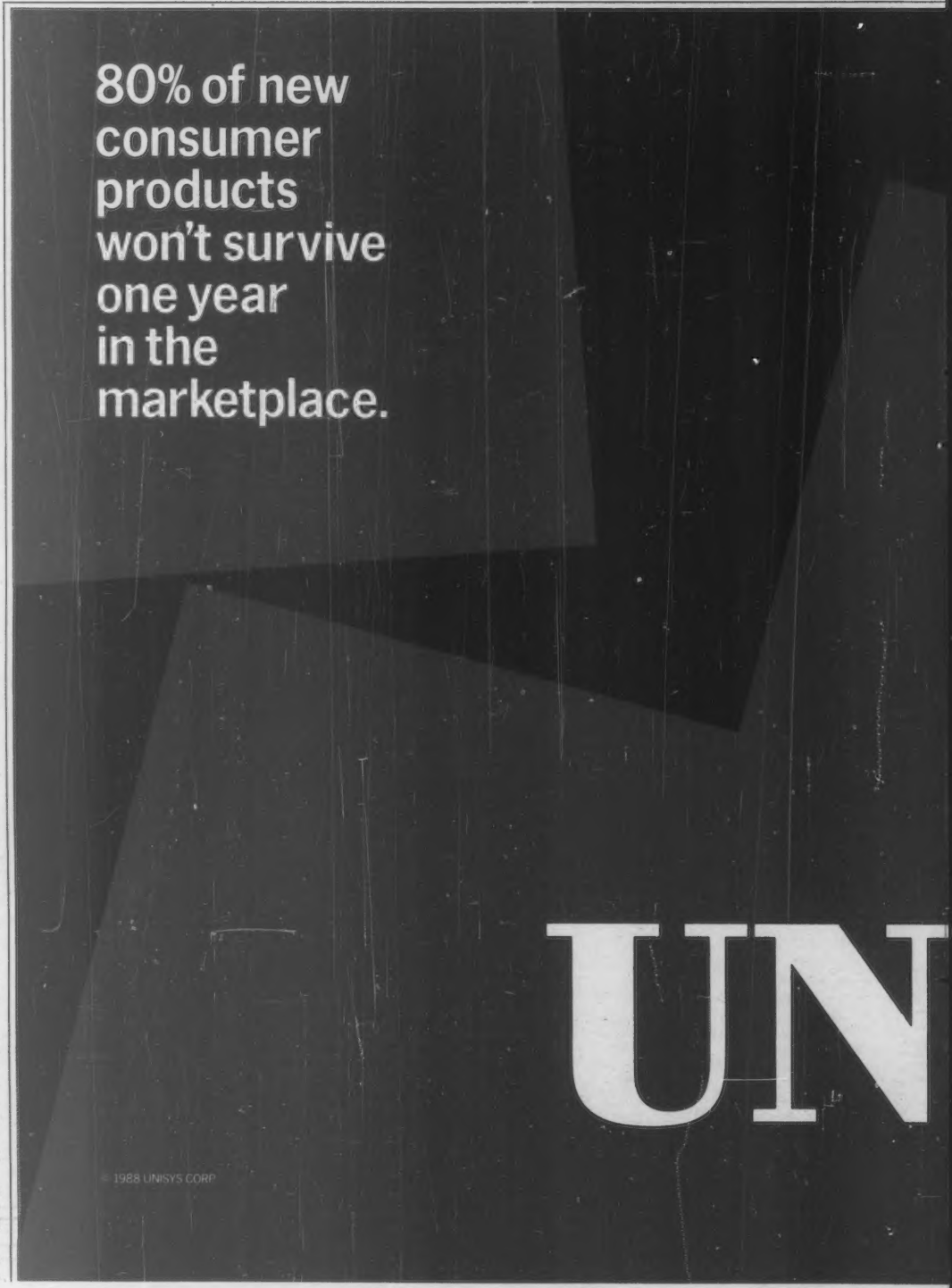
Meanwhile, as the recording of the cockpit conversation showed, no one noticed that the plane had begun a gradual descent that finally led to its crash. In my view, the captain could not discriminate between the potential problem with faulty landing gear and the risk of crashing.

I collect stories about failures of major MIS projects. Almost everything can go wrong — and frequently does.

- Everyone took shots at Price Waterhouse consultants for misjudging the efficiency of a new data base package, even though the New Jersey Division of Motor Vehicles was initially enthusiastic about the proposed solution as a cost-saving short-cut.
- When Bankamerica Corp. was going to spend $5 billion on integrated MIS operations, everybody applauded the firm's farsightedness. Then MIS Chief Louis Mertes left the company in the wake of the failure of an $80 million accounting package.
- Congressional committees looking for revenue supported the Internal Revenue Service in a $300 million reprogramming project until the Auditor General found problems with conversions to Cobol.
- Blue Cross/Blue Shield of Wisconsin apparently lost records during an all-out effort to realize large operating savings.

What do these cases have in common? They can be traced to a disregard for making explicit, formal risk assessments at the launch of a major program. The original sponsors of computerization projects become so engrossed in their greed to pocket theoretical gains that they disregard an old gambler's rule: All large productivity gains are a bet and all extraordinary productivity gains are a hazard.

Computer project sponsors, vendors and MIS managers forget that the U.S. achieved its current economic standard with less than a 4% steady annual productivity gain over a 100-year



period. Why, then, is there the compulsion to quote 50% to 1,000% productivity gains for computer projects?

For instance, a recent popular book, *The Information Edge*, details 63 case studies with annual productivity gains averaging 1,000% and up to a spectacular 100,000% gain per annum.

Why are so many of us willing to commit to foolish promises? The fact is that making promises is so easy. In contrast, quantifying the betting odds of the proposed venture is not seen as a desirable agenda item when selling a "strategic" system.

Bogus productivity claims — like lottery advertising — are rarely based on an obvious misrepresentation of facts. I usually find them embedded within elaborate feasibility studies.

I recently examined a very pretty 121-page proposal for spending $25 million on an innovative customer service support system. The spreadsheet tabulations filled 82 pages and contained, down to cabling length, specified program projections until 1994. The wealth of detail and the supporting time schedules, diagrams and systems charts were impressive.

The intrinsic fallacy of this study, as in many others, is found in which columns are added up in what way. For example, cash outflows in the next six months are subtracted from the expected cash inflows in the next five years. Easily verifiable detailed cash expenditures for equipment and telecommunications are subtracted from costs and savings. But there were other line items added or multiplied indiscriminately on the spreadsheet that I judged as ambiguous, borderline, doubtful, muddled, precarious, suspect or blind faith.

Even though, on average, the proposal offered very attractive returns, it hid the fact that, by my reckononing, the way the benefits are back-loaded, there is at least a 10% likelihood that substantial losses could result.

Try estimating

All forecasts are risky and all projects involving computers are unpredictable, especially when one estimates long-term benefits. I therefore advocate that productivity estimates — including computations of return on management — explicitly show the confidence limits one places on each significant element of cost and benefit.

In statistical terms, each cell on the spreadsheet should be defined as a probability, not a certainty. That is not the same as biasing the numbers so that results are acceptable. The sum of biased numbers yields an unreliable number. In contrast, the sum of probabilities from each cell reveals the underlying risk profile. It represents all interactions between known and unreliable estimates, which is something management should know.

Remember that productivity is not intangible. It is a measurable attribute of an organization as it manages risk-discounted cash flows. Vendors will not take intangibles as payment for equipment. Programmers don't get compensation expressed in units of competitive advantage.

Out there exists a cruel world that deals in terms of risky cash outflows and even more chancy cash inflows. Cash-based productivity measures are inherently simple — and badly needed to clear up the current confusion about how to figure out what productivity level to shoot for.

When you try to measure the output of information work, value — not quantity — is decisive. Since value in a knowledge-based organization is created by management and not by capital, the productivity of management should be computed by finding out what value it adds.

How you manage investment risks is the decisive factor of large productivity gains from information technology. Computer project proposals should reveal not only the expected outcome but also the best and worst probable outcomes.

How, then, can you tell what is real productivity? All you have to do is to compute the risk-adjusted cash flow of your management's value added. It might affect your outlook and even change what you do.

A computer system that gives you better information on your marketplace and your competition increases your odds for success.

And that's where Unisys makes the difference.

We are the leader in fourth-generation languages, sophisticated software that lets you anticipate changes in the marketplace, examine alternatives, and quickly plot a new course.

But that's not the only advantage Unisys offers.

We are a $10 billion information systems company doing business in over 100 countries, so we can help support your new product wherever it might be introduced.

Our complete line of integrated hardware, software, and networking systems can be tailored to meet your company's needs and can easily grow to keep pace as your markets expand.

We believe that better information leads to better decisions.

And we know that you need both to survive in today's competitive marketplace.

BETTER INFORMATION. BETTER DECISIONS.

i SYS

The power of 2

How to handle any executive attitude

By Cyrus Gibson and Robert Buday

It's hardly worth buying a stylish Maserati if you leave it in the garage or only use it for a slow commute on crowded streets.

Yet most businesses do the equivalent — invest heavily in the visible manifestations of information technology and then use them to only a fraction of their potential.

For example, a retail bank took an early lead in automated teller machines (ATM). Ten years later, however, it found itself seriously behind.

The bank lagged in linking to the networks of other banks. It lost the leadership of its ATM champion when he switched jobs. And needed enhancements to the ATM system fell victim to cost controls.

In another instance, Roger Smith, chairman of General Motors Corp., espoused a widely publicized vision of information technology in the early 1980s. Uniform data bases and common systems would underlie the paperless office. Robotics would reduce the cost of manufacturing. Microprocessor technology used in assembling GM's future Saturn cars would win back market share from the Japanese.

Today, GM's investments are widely criticized as either underused or misused. Smith held the vision, but it appears GM's senior management underestimated how much change would be necessary to implement it.

As these examples demonstrate, the buck stops at the top. MIS managers often get caught between what they and their end users see as the promise of information systems and upper management's technological myopia.

Top executives' attitudes on information systems fall into five categories:

- Technology is a disease.
- Technology is a cost.
- Technology is a tool.
- Technology is a means.
- Technology is a catalyst.

You can recognize executives who regard information technology as a disease: They take a negative attitude toward virtually any system. Although members of this category are probably the rarest, these information-age Luddites are most likely more common than most people realize.

The impact of the disease attitude on the organization is extremely inhibiting, and there is little chance that the executive will directly approve or participate in the expansion of technology.

Of the five attitudes, the dis-

Gibson is a senior vice-president and Buday a senior associate at Index Group, Inc. in Cambridge, Mass.

FIVE TYPICAL EXECUTIVE ATTITUDES TOWARD INFORMATION TECHNOLOGY

Information technology is a disease; we should eliminate it	Technology is a cost; we should reduce it	Technology is a tool to work faster; we should use it when hard measures show benefits	Technology is a means to make better management decisions; let me at it	Technology is a catalyst for new ways of doing business; let's invest in it

INFORMATION PROVIDED BY THE INDEX GROUP, INC.
CW CHART: AMY J. SWANSON

USER VIEW

Gerald Simonson
Project manager
Martin Marietta Astronautics

As part of a three-year project completed in 1986, a group of 42 engineers at Martin Marietta Astronautics in Denver showed substantial gains from using personal computers.

The engineers reported a 24% savings in labor hours, a 62% rise in quality, a 28% increase in creativity, a 52% gain in quality of work life and a 35% improvement in efficiency.

The engineers were among about 200 white-collar professionals conducting technical studies and preparing technical proposals. Midway through, they participated in a study by accounting and consulting firm Peat, Marwick, Main & Co. on the value of using Apple Computer, Inc. Macintosh computers. I believe that the measurement techniques used are applicable to office professionals in many industries, and the results there might be just as dramatic.

My interest in measuring the productivity of personal computers began three years ago when, as manager of technical and management information systems, I was charged with identifying methods for improving productivity.

Intuitively I believed PCs offered the most potential. Earlier, during beta-testing of Apple Lisa computers, I had learned to appreciate the importance of graphics to engineers.

Engineers think and express themselves with graphics. In addition, they use graphics to explain concepts to their peers, superiors and customers. The Apple Macintosh and LaserWriter produced block diagrams, schematics, tables and descriptions of configurations and design concepts faster and better than any of our older tools.

The 90,000 view-graphs we produced in the first two years of our project testify to the importance of graphics to engineers.

By the end of the first year of our project, we had acquired approximately 70 Macintoshes and 30 IBM Personal Computer XTs. Although the engineers believed their productivity had improved, we weren't able to quantify it.

Talking it up

The Peat Marwick team began with interviews of the project vice-president and directors to identify business concerns and objectives. The team then interviewed technical managers to learn about work flow and methodologies.

The third phase involved the organization of focus groups — six to eight engineers with similar work responsibilities and experience using micros.

Each person in a focus group assessed the impact of personal computers on each of his activities: How many hours did the task take before using personal computers? How many hours after? The focus groups also rated impacts on quality, quality of work life, competitiveness and overall effectiveness.

Several weeks later, we circulated attitude surveys designed to quantify other aspects of productivity and to verify information collected in the focus groups. The surveys confirmed the focus group results.

The average labor savings reported for the first year were dramatic enough; however, a more thorough analysis of the results revealed that productivity increased in the second and third years as users gained experience, learned new application programs, increased their use and acquired better and faster hardware and software tools.

White-collar office work tends to expand to fill the budget available. When engineers are given new tools to reduce labor costs, their budgets must be reduced or the savings will be frittered away.

ease view is the most difficult to change directly. The best strategies may be to wait for some crisis, or to influence the executive through his peers outside the company, perhaps through another chief executive with whom he is acquainted.

If you can create channels of approval and decision-making for technology that avoid the confrontation, you may be able to move ahead. But in the long run, given the power of most senior executives, those with the disease attitude are inevitably going to hamper the competitiveness of their organizations.

Control the cost

Perhaps the most prevalent executive attitude is the cost view of technology, which is seen in the continuous directive from above to control or reduce the cost of information systems. To a large extent, this view is propagated by what these executives see in reports — the cost of development and operations.

There are two typical outcomes in the organization dominated by the cost-oriented chief executive officer. First, technology generally is severely underused. The portfolio of applications is typically traditional and nonstrategic in nature. Often — especially in financial services — it also suffers from aging, with inadequate updates and maintenance.

The second symptom is the conflict between end users and MIS. Charged to control costs in the era of easy end-user access to distributed and stand-alone technology, the central MIS manager is caught between the Scylla of control and the Charybdis of demand.

Changing the attitude of the executive oriented to cost control is difficult but feasible. A key is to recognize that cost control is, in fact, an important attribute.

Help the executive build on that outlook to encompass a view of benefits as well. A major attack on the cost structure of MIS is an appropriate action for many organizations today. And recommending such an approach to a cost-conscious executive can instill in him a new level of confidence in you as well as an expanded view.

Automate and measure

The third executive perspective is almost as prevalent as the cost view. The view of technology as a tool differs, however, in that it is more balanced in respecting the benefits of savings. Executives in this category were frequently party to the automation projects of the 1960s and '70s.

Unfortunately, their attitude is suspended in that era, when systems automated processes and work without changing the nature of the work. The resulting "bolt it on" mentality saved labor or capital by substituting technology — but then, it also encrusted old processes.

The organizational effects are similar to those of the cost-view executive — large investments in old systems and avoidance of using technology to its potential for competitive advantage.

The efficiency-oriented executive can often be brought to see the expanded scope of benefits through presentations and seminars. Not suffering from a phobic inhibition or a one-sided view of the cost-benefit equation, this executive may be swayed by illustrations of how some companies and industries are using systems for new customer relationships or as the basis for new services or products. Where there is an interest, executives with this level of thinking can be introduced to hands-on use, an experience that can serve to broaden their thinking about technology.

The MIS view

The flow of batch reports and the availability of personal computers gave rise to a significant number of executives fixated on technology as a means to make better management decisions — the fourth common attitude.

A growing number of executives make quite effective use of executive support systems, and many more see the physical presence of a terminal or PC as evidence of the use of the leading edge of technology.

Like the automate attitude, this focus is not so much wrong as it is incomplete. It can also be wasteful: Companies run the risk of implementing executive information systems just to satisfy top executives' infatuation with an easy fix of management information.

> **The visionary view is about as rare as the disease view.**

The need, of course, is for those systems to be backed up with the capability of changing the way decisions are made, not just automating them.

The means view of technology can be broadened through workshops that focus on personal workstations as tools for customer systems, factory systems and the like, with no management information component.

The visionary

By far the most sophisticated executive view is the fifth one: Technology as a catalyst. This is the attitude of the visionary and leader, who sees information technology internally as a means for change and externally as a new opportunity.

The proclivity in this category, unlike the others, is to think in longer terms and to see spending for information technology as an investment rather than a cost, a project for measurable payback or a means to obtain management information.

Unfortunately, the visionary view is about as rare as the disease view. It tends to be held either by executives who grew up with extensive experience in technology or by those who have undergone a conversion — in some cases, one that is forced by crisis.

An example of the former is John Reed of Citibank NA; an example of the latter, Smith of GM.

While the visionary offers the best environment for exploiting technology, experience indicates that without combining vision with other views, it can lead to misuse and underuse as well.

Still, the visionary is typically the easiest to further educate. His or her attitude may be ephemeral and dangerously out of touch with what it takes to implement technology — such as drawing other managers into the process — but there is receptivity to the investment required and a willingness to hear the lessons of mistaken investment.

The most important lesson to be learned by these managers is that of involvement of other senior managers in the investment and implementation process. Without that involvement, the management of projects and change in processes and business as the technology is introduced, the outcomes can be the most wasteful and embarrassing.

In combination

Clearly, no one of these attitudes toward technology is enough. The disease view itself is to be avoided like the plague and wiped out whenever possible. The other four views are all needed at one time or another among senior executives. Although only a very few executives, in our experience, combine all four, there are a few executive teams in which all the views are shared.

For the MIS manager and the growing number of middle- and upper-level executives with broadened views, the limited attitudes at the top have become a source of concern, inhibition and frustration. Changing and expanding top executive attitudes, through education and exposure of all kinds, should be a top priority of these managers.

Dramatic productivity gains — not only of the measurable kind but of the strategic kind — can be achieved with information technology from here forward only when the executive mind-set is reset and appropriate actions follow.

To get the most out of the Maserati, the MIS manager must bring about new attitudes in the executives who increasingly control their fate. It is they who can rebuild the roads, change the route of the commute, and even drive the car to achieve its full promise.

COMMENT

Fred Wang
President, Wang Laboratories, Inc.

The 1980s have been good for vendors of information processing systems. U.S.-based businesses, nonprofit organizations and government agencies have invested hundreds of billions of dollars in the systems we make and sell.

But for buyers, the '80s were frustrating years. In spite of their investment in office technology, many enterprises did not achieve dramatic improvements in white-collar productivity.

Experts cite many reasons for this discrepancy, including lack of training, vendor-to-vendor compatibility problems, improper application of systems to business needs and slow development of software. I'm sure all these reasons play a part, but there is an even larger constraint on productivity, one that we tend to overlook because it is so familiar.

According to a 1987 Coopers & Lybrand study, computers handle only 5% of the information used in businesses, government and nonprofit institutions. The other 95% is still on paper — and generally inaccessible to existing office computer systems.

For example, a contracts management group in my company receives about 150 letters per week, in which customers report equipment moves and other changes that affect the status of their maintenance contracts with Wang. The 100,000 contracts on file in that group were produced by our internal computer systems, and the incoming letters were probably produced on the customers' systems.

Scaling the mountain

However, in spite of all the office technology used to produce the contracts and the incoming letters, the letters themselves become a paper-based problem for two reasons. First, every incoming letter needs to be matched up with the proper contract; second, the matching must be done by filing the hard copies.

This is just one small example of the "paper mountain" — the 95% of all business information that stubbornly defies integration into the sophisticated computer systems now in use. Computer vendors need to do something about that percentage if we want to help our customers achieve substantial productivity gains among their knowledge workers.

The paper mountain is growing — U.S. businesses are creating 930 million additional pages every day. But sheer volume is only part of the paper problem.

Thanks to office technology, it now costs only 25 cents to create a one-page paper document. But it costs $1.25 to retrieve a page once it has been filed. And if one page is misfiled or somehow misplaced, it can cost up to $120 to find or recreate it.

As a result of the widening customer demand for image-based systems, researchers now predict an explosion in imaging technology as it becomes integrated into existing information systems. For example, a composite industry estimate from the Association for Information and Image Management puts the imaging market at more than $2 billion by 1990. Eastman Kodak Co. estimates a $60 billion market by 1995.

Be prepared

In order to be successful in the 1990s, enterprises must be able to access all useful information, no matter what form it may take — data, text, voice or image; no matter where it resides — in corporate mainframes, departmental minicomputers, workstations, personal computers, recorded telephone messages or on paper; and no matter whose equipment is involved — from Unix-based workstations to mainframes.

In the decade ahead, we will progress from stand-alone imaging systems with rudimentary applications to sophisticated networks that allow images to be productively shared and integrated applications that allow the knowledge worker to access DP, word processing and image files from a single integrated workstation.

Right now, we're carrying off the small stones. During the 1990s, I believe the industry will move the mountain.

ILLUSTRATION BY JUSTIN NOVAK

Dust, thunder and justifying more PCs

By Avery Jenkins

With some companies having spent $5 million or more to equip employees with desktop computers, top management is beginning to wonder whether the expense has been worth it.

But whether or not a microcomputer is worth its cost is a tricky question to answer.

Take, for example, the airplane engine manufacturer that recently equipped some of its senior mechanics with microcomputers. One mechanic began downloading data from several different mainframe data bases, combining the information into a single data base.

Using Ashton-Tate Corp.'s Dbase to manipulate this combination of data, the engineer discovered that he could predict the lifetime before failure of a particular engine to within 18 hours.

"He probably has made that corporation $500 million over the next few years," says Marty Gruhn, vice-president of the Sierra Group, a Tempe, Ariz., consulting firm. "What, then, is the value of that PC?"

Gruhn tells this story to illustrate the point that it is extremely difficult to quantify the payback from PCs. With postpurchase audits and studies, "you can raise a lot of dust and thunder, but it's not clear to me that you achieve anything," she says.

Ted Freiser, president of consulting firm John Diebold and Associates in New York, says "Most companies do not accurately measure the productivity gain from PCs." But, he adds, "One of the real questions is, Should they?"

Measuring the benefits

The question is being asked more often now because the PC has been put to work in areas in which immediate productivity gains are less clear than before.

Some would argue that productivity gains in these areas are impossible. Neil Larson, president of software development firm Maxthink, Inc., says that the computer is nothing more than a tool to "speed up trivial processes," adding that only 30% of the activities in an office lend themselves to computation.

But in some applications, such as the word processing pool and accounting, productivity gains are more easily seen and often do not require a formal audit. Prepurchase justifications — such as a reduction in overtime — are easily compared with the bottomline reality a year later.

"I don't think anyone is doing postaudits," says Don Smith, a partner with the microcomputer services practice of accounting and consulting firm Price Waterhouse in Chicago.

He cites his own company, which has equipped all of its secretaries with PCs. No one has formally studied whether the company has saved money by investing in the equipment. But, Smith says, "We are getting by — I think — on fewer typists than we did in the past."

However, the PC has moved out of those production-oriented areas and into applications, where "the benefits are very soft," Diebold's Freiser says.

Marketing departments are using them for presentation graphics and desktop publishing as well as for market analysis. Managers are increasingly using PCs as budgeting, decision-support and communications tools.

And the benefits are difficult to measure.

The secret, the Sierra Group's Gruhn says, is to recognize that you cannot measure a middle manager's productivity, but you can measure his or her effectiveness.

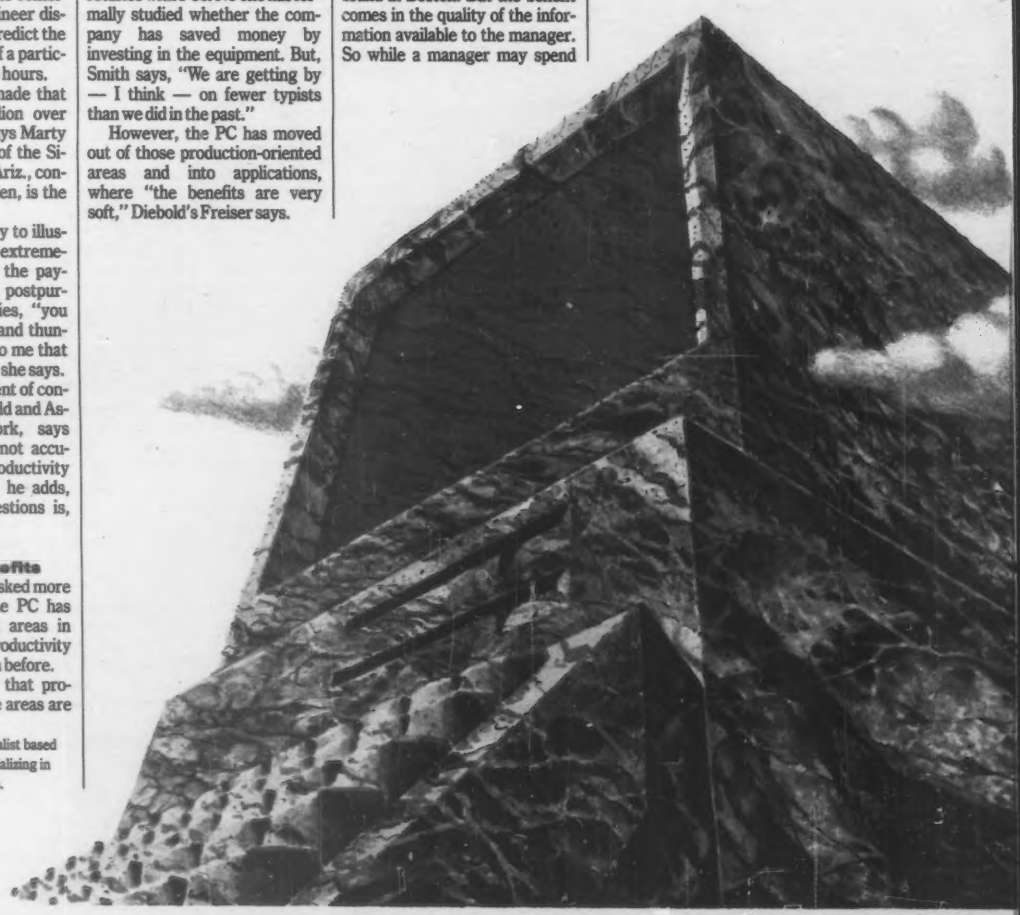
A PC will not allow a manager who makes two decisions in the course of a normal day to increase that to 10 decisions, but it may allow him or her to make better decisions.

"In some cases, micro-based solutions can take longer," notes John Cassella at accounting and consulting firm Coopers & Lybrand in Boston. But the benefit comes in the quality of the information available to the manager. So while a manager may spend more time making his or her decisions, they might be better decisions. Thus, the company benefits, Cassella says.

Studies, including one by Shoshona Zuboff at the Harvard Business School, have shown that increased use of PCs, particularly networked ones, is beginning to "flatten" firms, eliminating some middle management jobs just as previous automation diminished the numbers of clerical and support staffs.

The chief function of many middle managers is to transmit information between levels of the corporation. The networked PC can fill that function, and the elimination of middle management positions is one way a company can measure the effectiveness of its computers.

But Gruhn warns against



Jenkins is a free-lance journalist based in Newtonville, Mass., specializing in technology and social issues.

corporate America's tendency to follow a trend to its extreme. "The key is not to go out and buy PCs and then ax-murder middle management," she says.

The costs

If determining the benefits is difficult, when it comes to digging out the cost, "what you have is chaos," says Steve Stanton, a managing associate at consulting firm Index Group, Inc. in Cambridge, Mass. The cost of PCs is difficult to dig out of departmental and divisional budgets, he says, and use is almost impossible to measure.

In ones and twos, PCs are a low-cost item, easily hidden under a variety of headings in the departmental or divisional budget. Applications software, which is critical for determining the PC's benefits, can readily be purchased with petty cash. Thus, MIS departments are now accountable for justifying expenses they were not previously responsible for, Stanton says.

Many companies, however, have long instituted central purchasing plans, both to capitalize on volume purchasing agreements and to keep track of the number of microcomputers in the corporation.

Central management of the installed base will increase a company's return on the PC investment, according to Coopers & Lybrand's Cassella. This arrangement will foster some economies of scale, he says, through central development of applications and by providing a clearinghouse in which items such as spreadsheet templates developed in one department may be shared with others.

Index Group's Stanton identifies three levels of cost associated with PC use.

The first level consists of fixed costs, including those for communications lines, disk space and CPU time if the desktop computer is connected to a mini, mainframe or local-area network.

> **"Most companies do not accurately measure the productivity gain from PCs. Should they?"**
>
> *Ted Freiser*
> *John Diebold and Associates*

Stanton calls the second level platform costs. These include the computer itself, printer time and application software.

On top of these two expenses are the variable costs associated with use. They include the time and manpower the user spends developing applications, including those that do not work.

In addition to these costs, Price Waterhouse's Smith says, some accountants include training in the overall cost of PCs.

Some companies have been horrified at the rapid growth in support staff required by the influx of PCs, which has sometimes mushroomed, Smith says.

But he disagrees with the notion of including this expense as part of the individual computer's cost. Instead, companies should fold it into the other training classes offered by a company for its employees, he says.

The cost of a PC must also be compared with the cost of the alternatives, he adds. For example, if a company wants to automate a task or area, the PC is often the cheapest alternative.

Smith says he has found that a PC LAN usually costs half what a minicomputer with terminals running equivalent software costs. Most of that savings comes on the software side.

Diebold's Freiser cites the hidden cost associated with bringing in PCs. "What we have found," he says, "is that as the PC goes in, the previous support to the individual, the older systems, has not stopped."

Some measurement tools

In spite of the inherent difficulties of quantifying the effectiveness of a manager or the quality of an analyst's reports, there are some ways a firm can estimate the return on its investment.

On the prepurchase side, Smith recommends a rule of thumb comparing the annualized cost of a PC with an employee's salary. He says that on average, this figure comes out to about $2,000 per year, or 5% of the salary of an employee making $40,000 per year.

To justify the 5%, a firm only has to show that the computer will increase the employee's value by the same amount, Smith says.

Stanton also suggests a methodology for measuring the success of PC implementations after the fact. This method begins, simply enough, with finding out what senior management wants, whether it is a gut feeling that there is value, hard numbers or an impact on corporate strategy.

Most often, Stanton says, the question that management is really asking is whether the company is targeting end-user computing at critical areas.

This question is best answered by surveying a statistically representative sample of the user population, Stanton says. Investigators can then audit the most productive implementations — the top 5% or 10%. The top 5% "invariably provide enough demonstrable benefits to justify the entire expense" of end-user computing, Stanton adds.

Other experts agree that a companywide, intensive audit of the existing PC installation would be more trouble than it is worth. "I doubt whether we would want to determine how many minutes a day [each PC] is being used," Freiser says.

"The way not to do it is try to measure every single person," Gruhn says. "That's not terribly popular . . . most people get tired of being measured."

Like others, Gruhn compares the PC with the calculator, typewriter and telephone. For many jobs, it is a necessary tool, and she finds it curious that so much attention would be directed at the PC while equally expensive items are taken for granted.

"If companies knew what they were paying out for a telephone, they would turn blue," she says. But while a PC may not cost much more than a telephone, not everybody needs one.

"The conventional wisdom says everyone should have one on their desk," Smith says. "I think that's baloney."

PETER PERRY

USER VIEW

Timothy Turnpaugh

Executive vice-president, operations group, Seafirst Corp.

We measure productivity in the classic manner: the relationship between outputs and inputs. Since we are bankers, it is no surprise that we use dollars and cents to determine the cost of producing a product (input) and the value of the product (output).

The ratio between inputs and outputs at any point in time is not terribly interesting. We are much more interested in how the ratio changes over time. In plain English, are you producing more with less today than you were yesterday?

There is no doubt that technology has helped make us more productive. For example, in our main computer complex, we process more checks and charge-card transactions at less cost per item than ever before. Without the technology, we could not employ enough people to handle our current volumes.

In the network arena, we have implemented technology to transport more data and voice volume while driving down overall telecommunications costs.

In the workstation area, we are also starting to see productivity gains. Personal computers have been implemented to drive down costs and/or handle higher volumes.

These productivity increases are achieved by what we call "riding the technology curve." It means that we have substituted new, lower cost equipment to displace older, less efficient equipment; substituted technology for labor; and restructured our work force to employ fewer people who are highly skilled and paid more while reducing the overall personnel expense. In all three cases, it means doing more with less.

The implementation of technology has helped us improve the ratio of non-interest expense to revenue, a fundamental measure of productivity in a bank. However, are we really more productive in all cases? We can document the benefit in the main computer complex and the network, but the yield in the workstation environment is less clear.

What is the benefit of using a microcomputer to create a report more quickly and economically if the report does not add to customer service or increased profitability? We now have word processing programs to produce large, good-looking documents with proper spelling, grammar and style. But are they of any value? Or are we grading on weight?

How about the spreadsheet that calculates a return on investment to four decimal places, when everyone knows that the benefit yield cannot possibly be reinvested at the imputed rate? Or the desktop publishing efforts that are highly efficient but have nothing to say?

At Seafirst, we have two simple guidelines for investments in any form of technology: The investment must pay out fully in two years, and it must show a positive impact on earnings in the first year of its five-year life — not to mention the other four years. When we implemented this rule, some people said it would eliminate many projects or worthwhile "strategic" efforts. Quite the contrary; we still have plenty of projects bidding for resources, near-term and strategic.

Once management realizes that it can do more with less, it naturally chooses ventures that yield the highest payback. In short, productivity can really be measured in dollars and cents if there is sufficient discipline to do so. It speaks well of the purveyors of technology that their business segment has matured enough to understand the meaning of return on investment, just like those who deal with other forms of capital investment.

So the real answer to statements about widely heralded increases in productivity is simple: "What have you added to the bottom line? Have you increased your service to your customers, which also adds to the bottom line? Are you handling more volume with fewer people?"

Amazingly enough, these questions really are not tough to answer. Measuring the exact benefit exclusively attributable to a technology can be difficult, but it is fairly easy to see whether you are getting better or worse.

Don't stand in the way of the LAN revolution

By Anthony Ottavio

To enhance knowledge worker productivity, business has deployed more than 15 million personal computers at a cost of more than $100 billion. This broad-based investment was spearheaded not by the MIS department, but largely by knowledge workers themselves.

The widespread use of PCs is the latest phase in the quest for increased human productivity. The first stage was the industrial revolution, which targeted physical labor. The second, the computer revolution, addressed the collection, codification, structuring and retrieval of data through the use of mainframe computer sytems.

The current phase, the PC revolution, has further extended productivity by delivering computational power directly to the individual desk top. We are now about to embark upon a fourth phase of productivity enhancement, which will be driven by local-area network technology.

The reason LANs offer great potential for productivity enhancement is that they provide a foundation that draws on the investment already made in PC hardware and computer literacy for accessing data, integrating technologies and distributing information to end users.

• **Accessing data.** LANs provide the knowledge worker access to data that resides on mainframes, minicomputers, PCs or other sources almost anywhere in the world. In the pre-LAN era, when knowledge workers obtained data from the MIS department, it would usually be in hard-copy form and therefore not easily usable. LAN tools such as file transfers and downloads obtain data in machine-usable form from any source and deliver it directly to the knowledge worker's desktop PC.

• **Integration across technologies.** LAN-based knowledge workers using PCs can now access a wide range of technology tools, such as text processors, graphics packages and image-handling systems. In many organizations, these capabilities are located in stand-alone departments and are not easy to bring together.

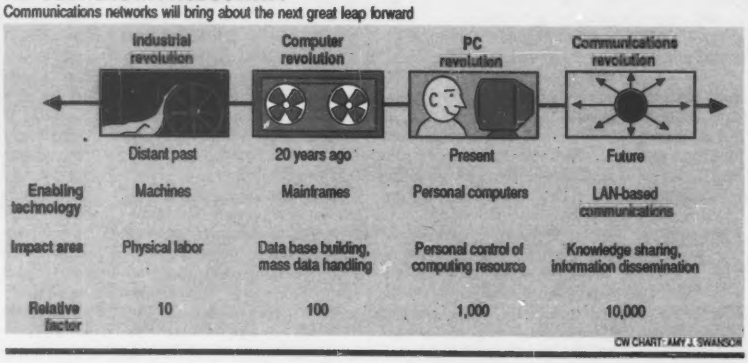
Because LANs can bridge PC-based work groups, they can be used to integrate the work product of various departments into a single unit and then either create hard copy or transmit the results in electronic form. In a LAN environment, the individual knowledge worker can control this integration.

• **Dissemination to end users.** A key area to be enhanced by LANs is that of dissemination and distribution of knowledge to end users. Compiled information is currently delivered to its final destination primarily via delivery sytems such as courier, postal service, facsimile machine

Ottavio is MIS director at McKinsey & Co. in New York.

REVOLUTIONS IN PRODUCTIVITY

Communications networks will bring about the next great leap forward



CW CHART: AMY J. SWANSON

USER VIEW

William Eaton
Chief information officer
Levi Strauss & Co.

Over the long run, productivity determines when one company will displace another in the marketplace, when functions will shift between departments and when new technology will displace older technology.

At Levi Strauss, we are well aware of the need to maintain and improve productivity in all facets of our business.

The challenge for the information resource function is to provide the infrastructure and architecture that allow processing of daily business transactions and downloading of information to end-user workstations.

This function provides the platform for the increased productivity available from the flatter, more empowered organizational structure that ultimately will characterize the Information Age, replacing the highly hierarchical organization associated with the Industrial Age.

Within information resources, we are focusing on an integrated development environment and an integrated applications architecture.

The development environment is aimed at an information engineering approach that provides capabilities like application development tools; security; and data base, hardware and systems software environments.

The integrated applications architecture, which we call Levi Advanced Business Systems, is focused on ensuring that we continue to build a system that works throughout Levi Strauss. We hope to increase productivity by ensuring that systems meet business needs and fit with one another.

As part of the development environment, we are prototyping products that provide a standard environment for mainframes, minicomputers and micros. In addition, we are implementing a tailored development methodology appropriate for the times and pursuing the integration of computer-aided software engineering tools and equipment for improving application programmer productivity, such as workbenches. We have implemented a quality-enhancement process with the objective of "Doing It Right the First Time."

Information technology is also being used in a number of ways to improve overall company productivity. Levi Strauss is rapidly rolling out electronic data interchange (EDI) with its trading partners. Service to these customers can be maximized by adjusting our production to meet their retail sales.

The use of an integrated systems architecture at the broader company level will reduce the need for information reconciliation and re-entering. We are also addressing company productivity through the use of end-user computing tools integrated with the total development environment and the information-engineering infrastructure, allowing delivery of relevant information to end-user workstations for decision support.

or electronic mail.

While the latter methods are electronic, they can modify the internal data structures, making further computer processing by the receiver difficult, if not impossible.

LAN communications facilities, on the other hand, can transmit all types of data with internal structure preserved to allow immediate processing by the receiver. LANs provide this value-added functionality because they are technologically consistent from end to end.

The major obstacle

There are a number of obvious impediments to the more pervasive use of LANs, such as the newness of the technology, the lack of industry standards and the small but growing number of LAN-based, multiuser applications. However, one of the major obstacles to the wider use of LANs is that MIS departments have, until now, not come out and strongly supported this technology.

Until the PC made its appearance, MIS had been operating more or less the same way for almost 20 years.

This problem has its roots in the advent of the PC some years ago. Until the PC made its appearance, corporate MIS departments had been operating in more or less the same way for almost 20 years. They implemented and extended the computer revolution based mainly on large, complex, central electronic data processing installations connected to their clientele via dumb terminals.

Over the years, hundreds of billions of dollars of largely immobile systems architecture has been implemented based upon this scheme and reinforced by highly specialized technicians trained to solve information problems primarily through the use of bigger and bigger mainframes.

Politics

Attempts by users to implement their own local solutions were usually diverted by MIS department hostility in the form of formidable corporate justification procedures.

In many cases, MIS understood the message of autonomy being sent from the ranks, but was powerless to respond in a timely fashion because the mainframe-based system and technical skills were not structured to address the new information needs. It was not solely a case of MIS reluctance to distribute the status quo. Rather, MIS simply couldn't switch gears fast enough.

In this context, it is easy to see why the MIS department was blindsided by the PC and largely failed to participate in the PC revolution at the grass roots level. In fact, it never did recover and get fully behind the personal computer. However, because micros were so cheap, users were largely able to bypass MIS to satisfy their pent-up demands for increased personal control over their data.

Just as end users seized upon the PC and pioneered its use in the corporation, they are again taking the lead in implementing LANs, which they view as a natural extension of their PC activity.

Central review of acquisitions will again be bypassed as computer-literate users are quick to implement local solutions that bring them direct, visible benefits. The MIS department, meanwhile, is again lagging behind on these initiatives.

Impact on productivity

This situation could bode ill for corporate productivity enhancement efforts. The reason is simple.

Significant industrywide productivity gains were achieved in the microcomputer revolution largely because a de facto industry standard was established by IBM and Microsoft Corp. and was adhered to by more than 95% of the installed base. Productivity gains were accelerated because knowledge and experience could easily be shared among users, as there was a common foundation.

If the industry is to obtain the benefits promised by LAN-based networks, a high degree of compatibility and consistency will be required in LAN architecture. Because a generally accepted industry standard, such as that which guided personal computer acquisitions, does not exist today in the area of LANs, some leadership and direction-setting will be required to rationalize this area.

Industry was exposed to a limited risk in the PC revolution because technology choices were limited and users could, as a practical matter, only move in one direction. This will not happen in the LAN area, as choices and options are almost unlimited.

The probability, therefore, of achieving a consistent corporatewide LAN architecture using only bottom-up, local initiatives is practically zero. The results, both economically and in terms of productivity, could be quite disappointing for the business entity expecting high returns from investments in LAN technology.

The corporate MIS group now has a renewed opportunity to play a key role in shaping the direction of the communications revolution and in increasing productivity within the corporation. In order to do this, however, the MIS group must first achieve the following:

- Change orientation. MIS must change from a centrally oriented, big-system, "one-size-fits-all" mind-set to a more user-oriented approach to business. This does not mean that MIS must now customize applications for each user. However, it must become a proactive facilitator and supporter of end-user, LAN-based computing.

MIS must enthusiastically provide LAN facilities and applications and actively assist knowledge workers in extending their individual knowledge development capabilities.

In addition, MIS must accept the reality that in the future, end users will provide an increasing portion of new technology ideas to the corporation. MIS managers must be positioned and disposed to accept this input and leverage it for the benefit of the corporation.

- Build interfaces. MIS must ensure that standard interfaces and tools that facilitate end-user access to data are put in to place and that an end-to-end LAN-based network is made available for internal communications and for the distribution of corporate information products.
- Establish a standard. MIS must take the lead in establishing an enterprisewide LAN technology architecture. The MIS group is well-suited to this role, as it has historically had responsibility for implementing corporate-level technology functions.

Additionally, MIS is ideally situated to address the issue from the "big picture" direction, something the local user usually cannot do. The desired standard must be tight enough to ensure end-to-end, seamless connectivity but open enough to provide substantial opportunities for experimentation and innovation by computer-literate users.

Ready to go

In summary, businesses are now poised for a major boost in knowledge-worker productivity. The vehicle for this gain is LAN technology as it leverages the investments already made in PCs and also provides additional synergies via greatly enhanced communications and data integration facilities.

There is no issue as to whether LANs will become pervasive. The issue is who will take the lead. End users, flush with victory on the PC front, will eagerly go forward with LANs as they clearly perceive the benefits.

The danger in letting the end user unilaterally make architectural decisions that could potentially affect the entire organization is that there is simply no guarantee that solutions that are optimal on a local basis will produce similar results at the corporate level.

Reading right

By David Black

You, like many in business, are faced with the constant demand to assimilate more and more information faster and better to maintain your competitive edge.

MIS professionals, in particular, face an enormous requirement, with more than 30% of your business time spent reading. Yet more than 80% of you claim you cannot keep up with the required reading to remain current in your field. You're not alone.

In the typical office, "in" baskets are piled high, and stacks of magazines, days-old newspapers, trade journals and various newsletters wait

CHRIS SPOLLEN

on credenzas to be read. Some documents need more thorough reading than others, but all of the material *should* be read — that's why it is saved. Even seemingly trivial material still needs to be skimmed, if only to determine its worth.

Few of us on the receiving end of this print deluge would question the value of a more efficient means of dealing with it. The ideal would be to read the material more quickly, without any loss of comprehension. But how?

The capability is in us to improve dramatically; we simply lack knowledge of the techniques. As a result, most of us are struggling along with reading habits we learned in elementary school. Here is a business activity that consumes three hours or more a day, and yet little, if anything, has been done to enhance this skill since childhood. It's no mystery, therefore, why most professionals still read at a grade-school level, despite having learned a larger vocabulary.

The main problem lies in the makeup of language itself — words. Words have little meaning until they are strung together into phrases, sentences and paragraphs. Then these basic elements of language emerge as the concepts or images that the author is trying to communicate.

Unfortunately, however, the untrained person does not read in groups of words. He struggles along, reading one word at a time, often regressing to reread words or passages and sometimes mouthing each word (mentally, if not physically) as he goes. The end result is fatigue, frustration, loss of concentration and poor comprehension, as the brain wrestles with the problem of extracting meaning from the badly organized, disjointed message it receives.

Why haven't we done something to improve? Maybe because we don't know the need exists. Reading is an activity we take for granted. We think we're doing fine, but what's "fine"? Without standards, we don't know.

Most feel they are average readers, and they probably are. Unfortunately, the average reader operates at less than 25% of his ability. Is this situation acceptable? The average golfer scores around 100 — a far cry from par and totally unable to compete on the PGA tour. Your situation is similar. The difference is, you are playing in the major leagues of business, and being just average isn't good enough to compete successfully.

Without proper guidance and instruction, it is very difficult to break slow reading habits. Why? Because the act of reading is solitary. Since no one can see what you are doing, including yourself, most people never learn what their problems are.

An advanced reading skills program — not a speed-reading course — will greatly improve your overall performance. It teaches you to discriminate. You could learn a flexible reading strategy to handle both the volume and variety of reading requirements. It puts you in control.

No matter what your reading ability is now, you can easily be twice as good. Imagine the benefits: an extra hour a day, better decision-making capabilities and an increased capacity to learn. In short, you'll feel better, think better and operate better.

Black is president of Improved Reading Centers in Old Lyme, Conn.

After automation: What now?

By Carl Thor

More than half the U.S. work force is now classified as white collar, according to the Bureau of Labor Statistics. Nine of 10 new jobs created through the mid-1990s are predicted to come in such heavily white-collar fields as communications, trade, finance, insurance, real estate and government.

It is these burgeoning service-sector businesses, in which

Automated garbage is even more dangerous than manual garbage.

two-thirds of all workers are white collar, that have turned in the sorriest productivity performance in recent years.

The American Productivity Center's analysis of labor statistics shows that for the past decade, there has been no growth at all in the service sector. We estimate that labor productivity in the nonfarm/nonmanufacturing sector actually declined — on average, 0.2% per year.

Thor is president of the Houston-based American Productivity Center, a nonprofit research and education organization dedicated to improving productivity and quality within companies.

The manufacturing sector has done better. Productivity grew 2.9% per year on average in the past decade — about the historical average.

Evidently, the service sector's sizable investments in computers have not helped. Stephen Roach, an economist at Morgan Stanley & Co., last year issued an ominous report on the failure of massive infusions of high technology to improve the productivity of so-called information workers.

"We have, in essence, isolated America's productivity shortfall and shown it to be concentrated in that portion of the economy that is the largest employer of white-collar workers and the most heavily endowed with high-tech capital," Roach wrote. The industries most lacking productivity were finance and insurance, retail and wholesale trade, transportation, business services, legal services and real estate.

Automation by rote

One reason computers are not boosting white-collar productivity may be that they are too often installed just to automate manual processes. This point was made by several chief executive officers who participated in a survey conducted in 1986 by the American Productivity Center and the consulting firm of Cresap, McCormick and Paget. The CEOs voiced concern about procedures being put on computers and then becoming institutionalized without first being examined and improved.

The executives also complained about the capacity of computers to churn out huge volumes of information. One CEO mentioned a four-inch-thick computer report that was circulated to his division heads. When he questioned them, he discovered that only 15 of its pages were of any use to anyone.

Proper settings

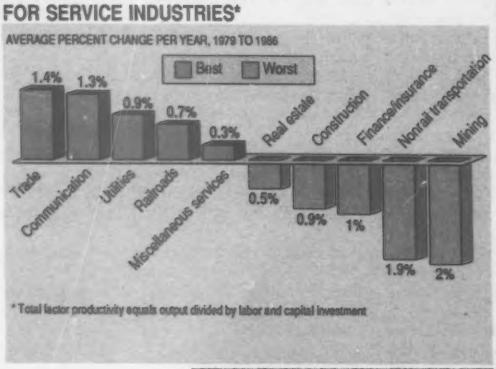
That's not to say there aren't white-collar settings in which automation can be critical — a prime example is the back-office operations of banks, where transaction processing speed is of utmost importance.

But most white-collar settings are more complex than that. The output of accountants, researchers and lawyers is much harder to quantify than that of assembly-line workers. The "products" of staff professionals are likely to be services delivered internally to other departments within the company.

And white-collar workers clearly make more discretionary decisions on the job than do production workers. Even in situations in which speeding up transaction processing is worth doing, there are larger issues to be addressed.

The American Productivity

TOTAL FACTOR PRODUCTIVITY PERFORMANCE FOR SERVICE INDUSTRIES*



* Total factor productivity equals output divided by labor and capital investment

INFORMATION PROVIDED BY THE AMERICAN PRODUCTIVITY CENTER
CW CHART

USER VIEW

Lemuel Lanier
Manager, information resources
Gillette Co.

We concentrate on three areas for improving productivity — technology, systems and people. You must have a balance of these elements. Under the right circumstances, any one element will increase productivity, but not to the maximum level.

On the technology front, we at Gillette have a well-balanced mix of personal computers, software tools, local-area networks and seamless links to mainframe computers. We make the best use of our people's time by putting the right technology in the hands of the end users. We have standalone micros for high-power analysis, LANs for work group reporting and an executive support system for easy data retrieval and analysis.

Systems are the glue holding technology and people together. It is rare that people and technology productively mix without appropriate systems. For example, you can provide PCs and spreadsheet software to assist users in performing their duties and they will complete their assignments — but at what cost?

We give people the right technology with proper training, appropriate links to data sources, customized applications and links to other systems. As we automate production lines, let us also automate our professional staffs.

Don't overlook the importance of creating and maintaining documentation to enhance productivity. Documentation reduces learning time for end users and programmers and accelerates future system changes.

People are the most important element in gaining productivity, and they too must be managed. You can't give people today's tools and let them operate in yesterday's mode and expect substantial productivity gains. As you plan and manage hardware and software upgrades, you must also plan and manage the change in the way people work.

Occasionally, you get a major system that greatly improves productivity. For example, by strengthening the monitoring of our business, our executive support system hastened the elimination of an entire financial forecast cycle.

Everyone seems captivated by the concept of productivity, and for good reason. The thing I like about the concept of productivity is that increased productivity means greater competitiveness.

Center has developed a participatively managed approach to white-collar productivity improvement, called Impact. In the past few years, it has been used successfully in over 25 firms. In the Impact process, groups of white-collar employees, typically at the department level, examine their work to discover its most important products or services. They then identify the customers for their products — inside or outside the firm — so they can collaborate with them in improving the quality of service.

The white-collar employees then develop measures to track the timeliness, quality and efficiency of production. They chart work flow in the department to identify elements that can be eliminated or modified without reducing quality.

Finally, they identify technological improvements that could enhance efficiency, quality or timeliness.

The focus is a dual one: efficiency and effectiveness. In contrast to many traditional approaches to productivity, Impact does not focus exclusively on efficiency. It targets effectiveness as well. Efficiency cannot be left out of any performance equation, but especially for white-collar groups, the question of whether the right "products" are being produced is critical. Automating a manual process may speed things up, but if the process was inappropriate or unnecessary in the first place, nothing is gained. Automated garbage is even more dangerous than manual garbage.

A critical distinction

There are two critical concepts in Impact. One is a distinction between activities and services.

Activities are discrete: running a tape on a mainframe or logging an employment application. Anyone's work can usually be broken down to the level of activities, and the purely efficiency-oriented approach to boosting productivity tends to concentrate here.

Services, by comparison, are major outcomes of work: producing an accurate financial report or publishing an employee newsletter or perfecting the design of a new jet engine.

A vital difference between an activity and a service is that in and of itself, an activity has no value to a customer. The department trying to hire a new training instructor isn't interested in how many employment applications the personnel function has reviewed if a good new training instructor never crosses its doorstep.

Activities are building blocks toward services, and services are the typical output of white-collar groups.

A good way to evaluate a service, then, is to examine its utility to a customer. The four-inch-thick report is a classic example of a service being produced that is of little use to anyone. So keeping a solid customer orientation is the second critical concept.

Putting the idea to work

The circulation services department of Official Airline Guides (OAG) provides a good example of a group that streamlined routine activities through new technology and developed a new sense of its services and customers.

OAG, a Dun & Bradstreet Corp. company, publishes travel planning aids such as airline and passenger-ship schedules and fares. Employees of the circulation services department, located in Oak Brook, Ill., process new subscriptions, update subscribers' addresses, generate mailing lists and handle customer complaints. This is the kind of work classically thought of in terms of transactions per hour.

When the department examined its work to identify its chief products and services, it declared customer relations as its primary function — all the activities the group carried on supported customer relations.

This insight changed the way circulation services does business. Managers computerized much of the time-consuming routine work, such as updating mailing labels, thus freeing employees to do a better job of customer service.

For example, previously if a customer did not receive a publication, the department would simply mail another copy. If the second one didn't arrive, a third would go in the mail. After going through the Impact process, the circulation service representatives would work with a customer to find out why a package didn't arrive. For example, it's easy for a piece of mail to get lost in the corridors of a large corporation. Often just adding an office or floor number to a subscriber's address will speed up or ensure delivery.

The department also began tracking mailings by ZIP code to see whether a delivery error was the post office's fault rather than OAG's.

Transactions per hour is still a legitimate productivity measure at OAG; promptly filling orders will always be important. But other measures of service quality have been added, related to complaints logged in and the number of guides re-sent because subscribers didn't receive them.

Internal 'customers'

But many white-collar departments serve only internal customers. Few external customers ever see the "products" of human resources departments, for example.

One such department at the McDonnell Douglas Astronautics Co. had its entire Huntington Beach, Calif., division as a customer. The mission was to "support the objectives of the division by providing for the acquisition and placement of employees while maintaining a competitive position within the labor market through effective organization, compensation and benefit programs."

Through surveys and interviews, the human resources staff identified a need: improving communication about the status of job applications. The division was bumping up against several obstacles in the hiring process:

- Administration and management were not consistently notified of offer acceptances, start dates, changes or delays.
- Information about applicants was often inadequate or misinterpreted.
- The employment staff could not immediately access original applications because the paper files were often taken out by other people.

To remedy the situation, the group redesigned its hiring procedure and created an automated system to track applicant information, generate acknowledgment letters and store records for the employee referral program, the job posting program, contract labor, transfers and promotions and classified advertising.

At another unit of McDonnell Douglas — this one in St. Louis — the personnel department gave other departments access to the nonconfidential personnel records of employees. A department could, for example, enter a change in an employee's shift schedule without going through the personnel group. The company documented savings of $1 million through use of this system.

Streamlining

At TRW's Space Park complex in Redondo Beach, Calif., two groups working to develop software for a military satellite used an old standby — word processing — to dramatically streamline paperwork.

The groups consisted of technical people designing the software and business people charged with reporting financial data to senior management and the Pentagon. One of the major products the groups provided was variance analysis reports, which are required by the Pentagon to explain why work is going over or under budget.

Before streamlining, the two groups sat in endless meetings — one per variance report, or about 40 per month — to work out a complete definition of why a variance had occurred and to make sure all the i's were dotted and t's crossed.

Then TRW simplified the process. The report form is stored in a word processing system so changes and corrections can be made readily. The groups reduced their meetings to once a week and signed off on a week's worth of variances at a time.

And the new process meant a dramatic improvement in the quality of variance analysis reports. Before, 50% of the reports produced had been rejected by senior management, usually because of inadequate explanations or missing information. With the new procedures in place, the rejection rate fell to 12.5% and the turnaround time after a report was rejected fell to one day — down from two weeks under the old procedure.

Ending turf wars

Information systems departments can also put the principles of productivity to good effect. For example, the MIS department at Atlantic Richfield Co.'s Los Angeles headquarters had been split into an applications group, which did projects for clients on the company's mainframes, and a microcomputer group, which bought and installed personal computers and software. The two groups often fought turf battles.

As it scrutinized its methods, the department decided to restructure itself into generic client-service teams that combine many functions formerly split between the mainframe specialists and the PC specialists. The group became far more service-oriented and now provides much more training and other support for clients.

As these examples illustrate, technology can enhance the productivity of white-collar workers. But to assume that just computerizing the usual work done in a department will automatically accomplish that goal is to remain naive.

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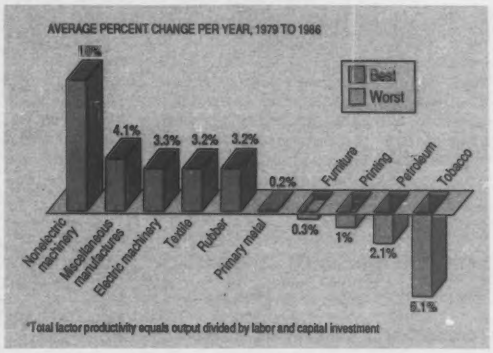

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Circle Reader Service Number 6

Manufacturing rebounds

By Brian Kaufman

Eight years ago, Dowty Decoto, Inc. confronted the high cost of improving productivity.

The maker of aircraft hydraulics started replacing its shop floor machines with computer numerical controller (CNC) technology. Two years later, with the addition of a manufacturing resource planning (MRP) system, it could measure shop floor productivity. Output per worker had started to soar, but so had the costs of creating and entering the extra information the controllers gobbled up. To hit pay dirt with the improvements, the company would have to cut its support overhead by 50%.

Dowty's case is just one example of the problems, decisions and surprises that often arise when organizations try to improve manufacturing productivity in the age of information systems. How does a manufacturer realize the full benefits of information and control technology — without giving up more than it gains?

"One car company which robotized 93% of its welds on one assembly line now admits that almost 20% of this work is not cost-effective," points out Paul Clermont, a principal at Nolan, Norton & Co., based in in Lexington, Mass. "That's a case of being too driven by 'Let's have robots' rather than 'What does it take to make things work best?' "

Companies that had rallied to the "Let's automate this factory" call have now taken up the "Let's run this factory right" mandate, according to Clermont. "Hardware and software is a necessary but not sufficient condition," he points out. "It all has to be integrated with how people work."

Charles Savage, a computer-integrated manufacturing (CIM) consultant at Digital Equipment Corp., puts it this way: "CIM is 20% technical and 80% organizational."

With the robot revolution having failed to deliver anticipated benefits — or even to materialize at all — companies must take a hard look at their structure if they want to achieve the full gains promised by expensive automation systems.

Companies must take a hard look at their structure if they want to achieve the full gains promised by expensive automation systems.

Eyeballing Inventory

This probelm was faced by Tektronix, Inc., a Beaverton, Ore., maker of oscilloscopes and electronic testing and service instruments, when the company extended its automation systems stage by stage.

"It wasn't easy to put it all in and get it working," Tektronix spokesman Fletcher Chamberlin recalls. "There had to be a whole mind-set change from the management standpoint. Management had to struggle, and that can be traumatic. But today the change is dramatic."

In the mid-1980s, Japanese competitors began underpricing Tektronix's low-end oscilloscopes by 25%. The company turned to manufacturing information systems to streamline operations. It also imposed a 10% cut on the size of its work force, which now numbers 17,000 worldwide.

To thwart the threat, Tektronix also took the following steps:

- Smoothed out its computer-aided design and engineering (CAD/CAM) systems, adding circuit board design software as well as its own design simulation package.
- Combined its data for electronic and mechanical designs into a machine control package to drive its board-insertion machines and to collect information from them to downgrade inventory.
- Brought in new MRP sytems.
- Honed in on quality, giving floor workers more control and encouraging them to shut down the production line whenever necessary — "doing it right the first time, rather than trying to 'inspect in' quality later," as Chamberlin puts it.
- Established manual just-in-time inventory management, doubling inventory turnover, which had been stable for 20 years. "It's a very simple system," Chamberlin says. "No computer control — it's visually looking to see if a bin is empty."

Between 1983 and 1987, Tektronix cut its manufacturing cost of sales by close to 13%, while its sales per employee jumped from $53,716 to $76,802.

Information systems did contribute to streamlining the factory floors — but that means a limited impact on productivity. "They were mostly due to improvements in manufacturing where labor has been greatly re-

Kaufman was a senior producer for the Public Television science series *Nova*, for which he produced the episode "The Robot Revolution?" He is currently an independent media consultant and producer in Cambridge, Mass.

duced," Chamberlin says.

"It's easy to replace welders with robots," comments Nolan Norton's Clermont. "Blue-collar productivity growth is fine; however, when it's down to 5% to 10% of the product cost, its impact is limited. Overall in the United States, productivity still stinks."

Mike Baldridge, Tektronix's informations systems manager, sums up productivity this way: "It's difficult to assess productivity gains due to information systems, because computers are necessary in this work — they're a requirement to do business today."

"In the overall picture," says Stephen Rosenthal, professor of operations management at Boston University, "technological capabilities are generally ahead of the practice of using them. It's an organizational barrier.

"Management and technical people have to change their thinking and be committed even when they hit bumps on the road."

Computer-aided planning

Bumps on the road jarred Yakima, Wash.-based Dowty Decoto as it drove to use CNC and extend MRP.

The company wasn't ready for CNC. While manufacturing productivity shot up, so did support costs. To reap the benefits of changes, Dowty had to reorganize the way the operation was managed.

It needed to cut the time between the design of a product and its production as well as the number of people involved in planning. The company invested in an integrated system that uses computer-aided process planning (CAPP) to link CAD/CAM and created a common data base as the centerpiece of a CIM strategy. The four-year installation began in 1985.

The CAPP system is aimed at cutting out a host of manually prepared lists and documents and communicating directly with the other systems. The company installed CAPP at the same time as the CAD system so that designs could address the constraints of the manufacturing process. The CAM system includes numerical control programs, tool design and MRP.

The network includes a McDonnell Douglas Computer Systems Co. Unigraphics II CAD system running on a Data General Corp. MV 400 minicomputer. The CAPP system is from Logan Associates in Milford, Mass., and runs on a Prime Computer, Inc. 50 series computer that was already holding a Heuristima MRP package.

The integrated system has cost Dowty Decoto close to $750,000, but managers feel that through integration and organizational changes they will be getting the most out of the new technology, which they expect to pay for itself in five years.

Among the benefits is a good retrieval library, according to Bill Wheeler, the company's president. "We won't have to design something a second time because we forgot that we once did it."

The payoff

Dowty Decoto says it is well on its way to acheiving its goal of cutting support overhead by 50% with completion of the integrated system. "We're satisfied. We're evolving it incrementally and have seen each increment pay off," Wheeler says.

But for every case in which

Continued on following page

COMMENT

Joe Henson
President and CEO
Prime Computer, Inc.

Not long ago, *The New York Times* ran an article on designing for assembly lines. The story said, "Until recently, industrial designers and manufacturing engineers did not have much to do with each other. 'We'd wrap the plans around a rock and toss it over the wall into manufacturing,' explained one design engineer who works for a large corporation. 'If it didn't come flying back in a few days, we'd assume they could build it.' "

This story is a paradigm of manufacturing today and one reason, I believe, that the U.S. lost its edge in productivity.

Just 30 years ago, the U.S. led the world in manufacturing capability, productivity and technological innovation, largely because of its collective efforts in World War II. Unfortunately, this is no longer the case.

Instead, we've seen other countries, particularly those in the Far East, master our production techniques, anticipate customer needs and adopt emerging technology skillfully and more quickly than we have.

But I do not believe, as others do, that U.S. manufacturers might as well concede the race for industrial supremacy to Japan or South Korea. Nor do I believe that the U.S. should supplant its manufacturing-based economy with one based on services. There is no way services alone can fuel the engines of a $4.5 trillion economy.

Instead, U.S. manufacturing companies must learn that if they want to survive, they can't throw rocks over the wall anymore. In fact, they must get rid of the walls — from a human perspective and from a technological one. We must work together in ways that we never before envisioned.

Perhaps the ability of the Japanese to work more cooperatively than we do is a lesson learned during many centuries of living close together on a few small islands. It is a lesson from which we could profit greatly.

Some of the critical issues that directly affect increased U.S. productivity include setting and adhering to standards, adopting technology to meet customer needs and, finally, developing strong alliances within and outside our own industry.

Stuck at a bottleneck

First, we need standards. Complex applications like solid modeling and animation are geared to one overriding imperative: to get products to market faster. Yet for all the progress we're seeing in some areas of the manufacturing process, there are stubborn bottlenecks. One reason is that we have yet to agree on the standards we will use for operating systems, data communications and data management.

Some of the largest companies have imposed their own standards, including General Motors Corp. with the Manufacturing Automation Protocol (MAP) and Boeing Co. with the Technical and Office Protocol (TOP). Any company wishing to do business with these firms or their thousands of suppliers must adhere to their standards.

For the manufacturing company hoping to connect and port applications across a variety of platforms from different vendors, emerging standards represent a ray of hope. For the computer vendor, the ability to implement standards and fit into such an environment becomes another differentiating factor.

But none of this is easy or inexpensive. Today, about 50% of the information systems installed in the U.S. support business operations. By 1990, that proportion will drop to about 33%; the proportion used to support design, manufacturing, engineering, production and resource management will rise to 60%. Clearly these operations must be more closely linked. Standards are an important part of the linkage.

Reality check

Second, 20 years ago, many people in the computer industry believed the day would come when companies would be run from top to bottom by so-called management information systems. From a terminal at his or her desk, the plant manager or even the CEO would be able to call up any information, cross-reference it with any other information, make a decision and communicate that decision to the people responsible for implementing it.

That's not what happened.

In reality, the way organizations work is much more complex than the visionaries understood. Other examples of these collective visions include the "checkless society" and the "paperless office." With all these visions, we embraced those parts that suited our purposes, adapted others and ignored the rest.

The lesson here is that any effort to computerize a task brings us face to face with the deficiencies in our understanding of it. Developers must learn to compare what they have developed with end users' real-world experience.

No company is an island

Finally, it's no surprise that mergers and partnerships are occurring at one of the highest rates in U.S. history. Largely because of increasing global competition and declining venture capital, such partnerships have many goals: technology exchange, increased market share and expanded sales channels among them. No company can do everything alone. The smart ones don't try.

What's next for American manufacturing? Is the answer to operate more like the Japanese, who seem to simplify a process first and then automate it — not expecting the technological solution to substitute for, or compensate for, the organizational one?

Or is the answer to buy more technology?

Long view

The solution is both. We know that advanced manufacturing techniques are never quick fixes. If a manufacturing operation is not already running efficiently, no amount of computerization will make it run efficiently.

In addition, firms concentrating on short-term profitability are less likely to purchase computer-integrated manufacturing solutions than are those interested in long-range growth, because advanced manufacturing techniques may not pay off immediately.

Appropriate technology is only part of the answer. The other parts are the intelligence, the listening skills, the imagination, the flexibility and the eagerness to explore that come with competitively — yet cooperatively — pursuing a common goal.

ILLUSTRATION BY JUSTIN NOVAK

automation and information systems are integrated to reap maximum benefits, there are dozens in which they are not. "In most shops, there are terminals and printouts," Clermont asserts. "But if you really want to know what the hell's going on, you have to go ask Frank, and that doesn't fly in a well-run factory. What Frank knows and what the system knows must be one and the same.

"It's bigger than the typical MIS director's job," he adds. "The problem isn't the choice of hardware and software, but how it's used. MIS people must be in the picture and be real hard-nosed in getting other people in the organization to make things work." Those steps include establishing standard data definitions and a clean baseline of data. "If you just take your old junk and throw it into the new system without checking, validating and laundering it, you can just blow yourself up," Clermont says.

DEC's Savage also emphasizes the need for standards. "It's definitions — and that's a people problem," he says. "There needs to be one definition of a delivery date or a bill of materials."

Upgrading to MRP II

DEC opened a $33.6 million manufacturing plant in Augusta, Maine, in 1979 and within several years faced the prospect of shutting it down. Sales of the plant's major output — network and communications products — were stagnant. Because of poor production planning and scheduling, the manufacturing lead times were too long in a field that demanded quick turnaround.

In 1984, the plant was given a second chance. Aiming for predictability in the quality and timing of work, it decided to pursue CIM by upgrading to an MRP II system, which integrates systems, data and people across manufacturing functions.

The move involved a major cultural change for the organization. It spent $1,000 per employee on training and established standard data definitons and a stable, accurate data base. "Integrated common data is the glue that holds everything together," plant manager Beth Reuthe says.

Today the plant lists among its achievements a 45% jump in output, an 18% cut in inventory, 50% less overtime, 50% fewer production defects and a 20% increase in productivity. Fewer employees control work in progress, and data-entry clerks are being retrained.

"These benefits could not have been achieved through hardware and software alone," Clermont says. "There was a major organizational change where the old managerial functional barriers were broken down."

In companies at which a critical mass of automation is already in place, many experts focus on management changes as the springboard for the next stage of overall productivity gain. They see hierarchical management broken down into a cross-functional teamwork approach, which goes hand in hand with integrating information systems throughout the company.

Going light on systems

Two years ago, Whistler, Inc., a Westford, Mass. manufacturer of radar detectors now with 185 employees, had to make a decision: Either turn productivity around or move production to South Korea.

Whistler managers knew what their problems were: inefficient use of manufacturing space, proliferation of inspection points, rework rates of 25% to 30%, collection of unnecessary data and excessive amounts of materials sitting in inventory.

The managers gave themselves two years to see what they could do. What they did not do was to turn to computers. They closed one of the two plants and reorganized the other to run with fewer manufacturing steps and employees.

"We had an MRP system, but we've made it simpler and easier to use," says Manufacturing Vice-President Richard Packer. The company eliminated modules — for monitoring work orders against products, monitoring the movement of products from one process to another and collecting data for analysis and categorization — that was never used.

Today, as at Tektronix, Whistler's just-in-time system is manual, and its line operators monitor production, catching defects earlier and doing away with most of its inspectors. It continues to use its Hewlett-Packard Co. minicomputers and microcomputers on the shop floor for tracking information on quality.

"The changes were gut-wrenching," says Packer, "but direct labor is down from 346 to 130 and supervisory staff from 30 to 10. Today we produce the same amount as a year ago with only half the direct labor. We've cut production costs by 35%. Rework is down to 5%, and we've slashed the production cycle from 22 days to three — without automation.

"We're information-systems-light here," he says.

In the early '80s, says Boston University's Rosenthal, "the groundswell of automation excitement swept up companies which didn't have the total dedication, resource and sophistication to do it properly — that includes General Motors — and it didn't work. But automation can be done successfully in one fell swoop if you're big and sophisticated and totally committed and know what you're doing."

Some of the showcases of automation are well known — there is IBM in Lexington, Ky.; Deere & Co. in Waterloo, Iowa; General Electric Corp. in Schenectady, N.Y.; and others. How are they faring today?

Intelligent manufacturing

Everything about the GE Steam Turbine generator plant in Schenectady is big. The products, the plant, the 1,200-member work force, the sales organization and the CIM network itself.

It was difficult to install the CIM system and get it running, according to Charles Herman,

Continued on page 26

USER VIEW

Michael Hallman
President
Boeing Computer Services

Webster's Seventh Collegiate Dictionary defines "productive" as "contributing to effect production" and "productivity" as "the quality of being productive." In simple terms, productivity is producing the highest quality product or service at the lowest possible price.

Webster's, however, also defines "productive" as "having the power to produce in abundance," and I think that's where many information systems departments misunderstand their contribution to productivity.

Too often, a productivity solution is to automate everything in sight. The automation of a wasteful manual process only allows the process to continue being wasteful, but now at electronic speed.

Boeing Computer Services' role in increasing the productivity of The Boeing Co. begins with participation in corporate strategic planning. Many information systems issues deal with how we're going to run our business and the most basic activities associated with designing, building, maintaining and supporting products.

You often hear that a particular business is too volatile for a strategic planning process. Volatility makes planning all the more critical. For instance, although we can't predict our product mix in 1992 at Boeing, I'm willing to bet that we will be producing high-tech products. And we're going to have to design those products, bend metal, fabricate things, support logistics and so forth. To the degree there's volatility in our product mix, we've got to build flexibility and adaptability into our information systems.

How much flexibility do we want in manufacturing? Do we really want the ability to build any product at any factory based on changing business mixes and relative costs? If so, we would need an entirely different set of information systems to support that strategy.

The strategic planning process helps identify common information systems that will generate benefits across multiple organizations and also recognize the uniqueness of those organizations. That leads to the integration question: "How do we get multiple, potentially disparate systems of separate organizations to work together?" We're driving toward a single electronic representation of the things Boeing builds.

Through the planning process, we can develop the justification for designing a system, but not just in the classical sense of cutting three parts out of an assembly or reducing the engineering head count by three people.

We believe we need to tie our planning activity into the overall business plans and financial objectives of each Boeing division.

For example, we need to understand each division's costs associated with scrap, rework and engineering changes and the value of taking 90 days or six months out of a development cycle.

Working against those numbers and issues, we can begin the structure of the overall systems plan. Such planning crosses disciplines and organizational lines and identifies major leverage points. That's how we can determine justification and affordability, which can then be spread over the years it may take to develop a system.

An artificial intelligence project operating in the manufacturing area of Boeing Electronics is a good example. This system, called Connector Assembly Specification Expert, aids shop workers in the assembly of electrical and electronic connectors.

Before this system existed, shop workers searched hundreds of pages of documentation each time they assembled a connector. Today, they can consult the AI program. The program has reduced the time it takes to locate a specification from an average of 45 minutes to two or three minutes. When fully implemented, it is expected to save millions of dollars each year.

The importance of planning cannot be overstated, because the investments required to implement advanced technologies are very large. Information productivity decisions must be made methodically, with a clear sense of purpose and with specific end goals in mind.

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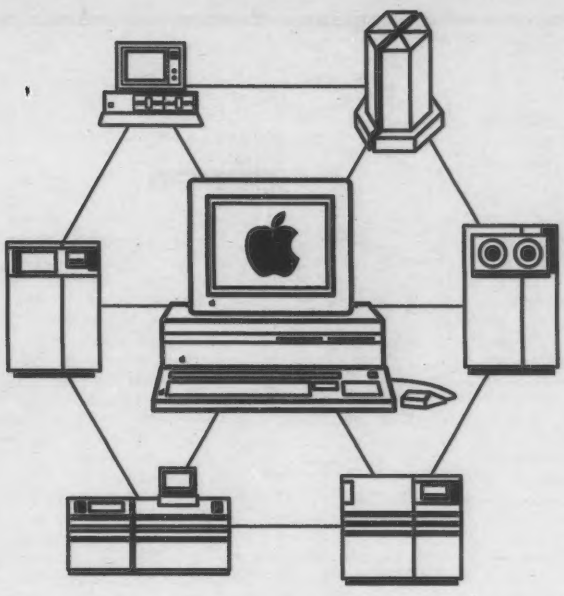

Vision of world change.

The two networks above are the same. The one on the left is how most IS professionals would design a network. The one on the right is how the IS&T (Information Systems & Technology) group at Apple envisions a network.

The difference? Apple's focus is on building a system with truly transparent access to information. An enterprise that could grow dynamically, instead of in discrete stages. One that seamlessly links employees, customers, and vendors worldwide. Regardless if the user is working with a micro, mini, mainframe, or even supercomputer. Distributed, parallel, or cooperative processing.

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Continued from page 24

manager of automated process planning. "All the possible problems arose, but we were backed by upper management, and that was important because we needed to make changes in middle management to implement the new systems," he says. "Of course, any new hardware system you bring in — a PC or mainframe — suffers a culture shock when it arrives, so you have to work on it. But up time is very good now, 90% to 95%."

The GE Steam Turbine Generator CIM network might begin in Italy or India. Each of GE's Steam Turbine Generator sales offices around the world is linked through GE's Information Services communications network to a Honeywell, Inc. DPSB8 mainframe in Schenectady, which holds most of the business systems and various design, engineering and manufacturing data bases.

GE is planning to replace its own business software with an MRP II system that will run on an IBM mainframe.

Directing traffic

As part of the overall CIM strategy at Schnectady, GE set up a process planning system to automatically route parts through manufacturing shops. The process combines GE's Part Recognition Code (PRC) on the Honeywell mainframe and a CAPP system from Logan Associates running on a Data General Corp. 10000 series minicomputer.

The key element is the PRC, which replaces traditional drawings by capturing all pertinent product definitions in a digital form, making possible distributed numerical control (DNC) — a numerical control process that is integrated with CAD and CAM systems. The system assembles a package of routing, materials and machine instructions. The machine operator calls this package up on the shop floor terminal, sets up the job and pushes a button to make a part.

"We're putting the intelligence into the manufacturing plant automatically," Herman says. "For the first time, the shop floor is getting consistent and accurate information."

From 45 planners and 35 drafters in 1981, GE Steam Turbine is now down to 10 and two, respectively.

"An order which comes in before noon can be on the shop floor at 7:00 the next morning, totally without paper," says Laki Kontronis, manager of advanced manufacturing systems. "Productivity is up 10% to 15% for both direct and indirect labor since 1984. There's 30% less inventory in the shops, and cycle time is down. What was an eight-week engineering-to-shop cycle can now, in a priority run, be down to 4½ hours, though a more standard reduction is from eight or 16 weeks down to one."

Automation showplaces represent only a fraction of all U.S. manufacturing.

The total system cost $30 million and pays for itself every one to 1½ years, Herman says. "It's been a pleasant surprise."

GE seems to have cut through the support problem for its shop floor by using information integration and DNC. Compare this approach with a firm that installs glossy new CAD but is still in the steam-engine age when it comes to moving the data through the organization.

Buried in paperwork

Situations like that worry Jerry Arcuri of consulting firm Datapro Research Corp. in Delran, N.J., who has written extensively on the subject of information systems and productivity. "If there's no integration, productivity suffers," he says. "Great designs don't get themsevles out of the door. You need to link CAD to CAM and the shop floor."

Typically, engineering drawings need 17 signatures before approval. In some large companies, there are horror stories of the complexities of managing drawings — of areas buried in paper, instruction sheets mixed up and paper delivered to the wrong place or at the wrong time.

In U.S. industry as a whole, Arcuri still sees very little linkage between CAD and MRP planning. "The flow of materials isn't automatically generated so inventory control and financial planning and shop-floor scheduling are improved," he says. "Even when they have the software, they don't make full use of it. Users of MRP don't take advantage of all its capabilities. Different departments use different systems. Upper management must make the commitment — and that, in general, is lacking.

"Larger companies, generally, are more effective, while mid-sized companies are not doing much with MRP," Arcuri adds. "Integration can cost half a million dollars for a small company."

Nevertheless, between 1981 and 1987, productivity growth in U.S. manufacturing averaged 4.2% per year, well ahead of the 1.3% rate between 1973 and 1981 and far greater than the service sector's 0.3% rise from 1981 to 1987.

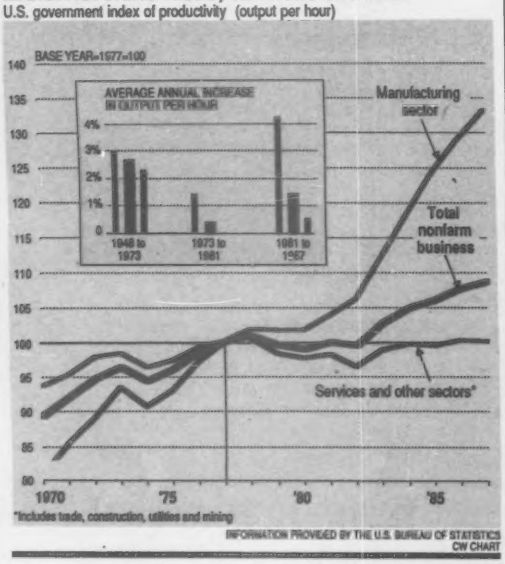
The well-known automation showplaces still represent only a fraction of U.S. manufacturing. Yet the message is clear: The problem is in management and organizational inertia. The tools are at hand. Will the determination to use them follow?

DEC's Savage foresees a time when management changes will free creative people to help their firms realize the benefits of the automation technology that is already here. "The '90s will be the decade of the data in creating reference architecture so that different functions can work off the same models rather than interfacing a plethora of applications that have different defintions of the same items," he says.

Information systems and automation have helped American manufacturers increase their productivity in the last decade; but the changes have yet to be widespread or comprehensive enough to outstrip the gains in other countries.

MANUFACTURING RISES; SERVICES STUMBLE

U.S. government index of productivity (output per hour)



*Includes trade, construction, utilities and mining

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CW CHART

COMMENT

W. Michael Blumenthal
Chairman, Unisys

If the computer industry is to maintain its historic growth, it must transform today's software development mind-set to one in line with the 21st century.

Application development backlogs have become serious drags on the productivity of all industries — manufacturing, distribution, steel, automotive and finance, to name just a few. To manage change effectively and to gain competitive advantage, companies need to continually improve their overall productivity as well as gain the flexibility to develop unique, value-added products and services in a timely way. Today, many MIS establishments can scarcely keep up with maintaining old applications, thus making it impossible to deliver new applications on budget and on time.

The major source of bottlenecks — as well as a lack of flexibility — in MIS organizations is the rigid, slow-moving process of programming with third-generation languages.

Given continuing and rapid change in the economic environment, the relatively static nature of the third-generation language programming art becomes more of a burden. Most surveys show that just 10 or 15 years ago, hardware costs accounted for 60% to 75% of a typical system, with software taking up the rest. Today the reverse is becoming true.

Furthermore, our industry and its users are challenged to keep pace with the exponential growth of hardware performance in two other critical areas of information management.

One is openness and interoperability, meaning the ready portability of solutions that users need to run their businesses. Another is networking, the ability organizations need to manage the flow of information.

These are areas in which technological innovation lags, and they are all related to software, not hardware. Information systems suppliers, like all companies, must respond to this pressing requirement by taking a hard look at their traditional assumptions and approaches. In fact, a new productivity mind-set is called for — one that is willing to question the status quo and, where appropriate, reject it.

For example, it is time to attack the software bottleneck issue by reaching beyond the third-generation language world to a higher level approach that is, in a sense, independent of hardware and architecture. That's where computers start becoming what they should be: transparent to the user. Users need a powerful environment built to provide maximum productivity and flexibility.

This higher level environment must go beyond the popular computer-aided software engineering tools and so-called fourth-generation language development systems. What is needed is a complete information system environment that runs across multiple architectures, including Unix.

However, this comprehensive capability requires a basic change of mind-set for programmers and MIS managers whose training and experience are rooted in the slower third-generation language programming techniques.

So the real challenge in breaking the software bottleneck is not a technological one. It is the more difficult issue of rejecting the status quo and opening up to a new mind-set. The ultimate industry-wide break with the old world has vast implications for computing and for the world economy, just as the break with earlier technologies produced today's information processing industry.

The Information Age is here. It will not be slowed or thwarted by old approaches or by the politics of computing. Software productivity and flexibility, real system openness and total solutions in which technical complexity is transparent to end users are driving the information systems industry. They are the basis of a new and compelling economics of computing in which the MIS contribution to a company's success will be measured in terms of the flexibility and control it gives management in managing change for competitive advantage.

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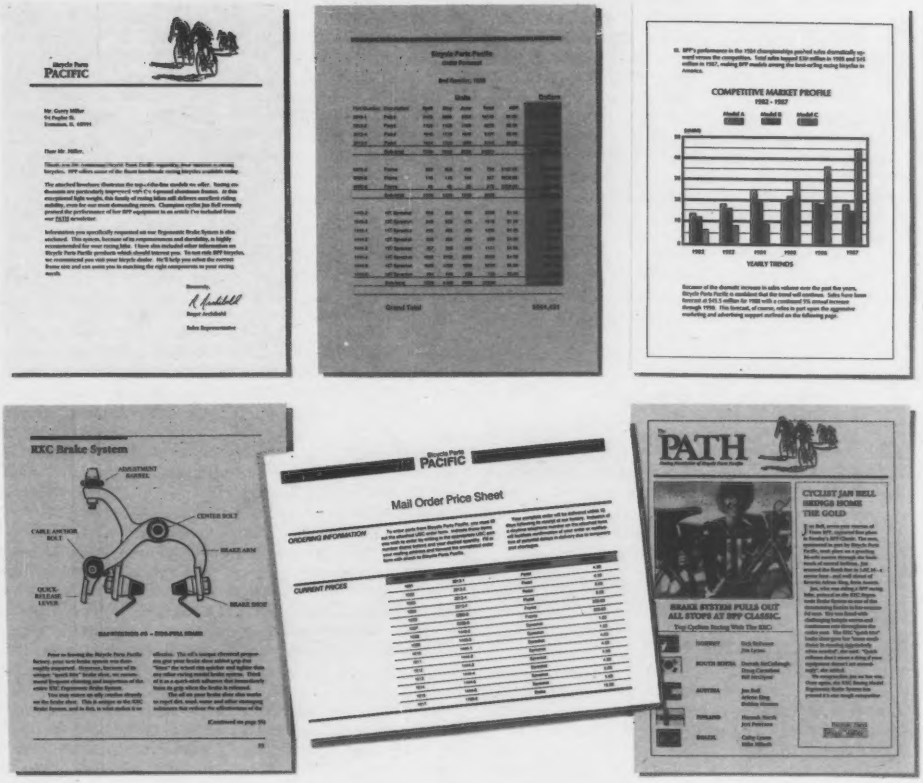

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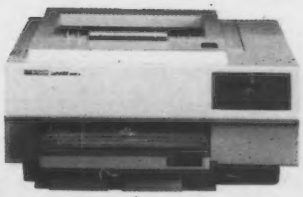

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Circle Reader Service Number 9

Report the good news to your CEO

By M. Victor Janulaitis

During a major cost-reduction program, the chief information officer (CIO) of a large service organization was asked by the president of his company to prepare a presentation on how the data processing function helped the company meet its productivity needs. "I do not want to have a presentation on the acronyms you are working on," the president said. "You will only have 10 minutes to summarize the contribution of your function."

Fortunately, the CIO had just implemented his own EIS and developed an MIS Performance Report that he could use to communicate with management. Without this tool, he would not have been able to present his case.

We all understand the importance of doing an excellent job. Unfortunately, too often we do not also understand the importance of communicating to senior management what we have accomplished and at what cost. The success or failure of an MIS executive is often measured by how others perceive the job that he and his group are doing. For this reason, we must explain our successes as well as our failures. The adage that "no news is good news" no longer applies.

The missed opportunity

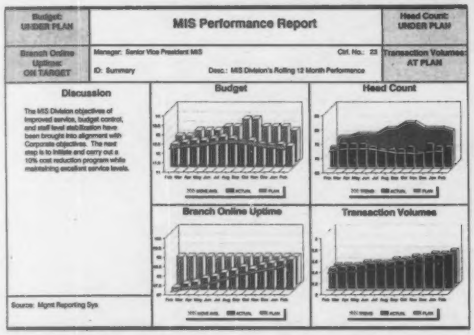
Many companies have not focused on productivity but on cost reduction and cost containment. Often, people will look at computer-integrated manufacturing (CIM) and only see the cost associated with the recapitalization of the plant, the write-off of undepreciated assets and the use of key management outside day-to-day operations.

The view of this effort should be on the additional capabilities CIM brings to organizations. These capabilities could include improved product quality, ease of retooling and reduced direct-labor costs.

Computer and communication goods and services are the new manufactured products of the information revolution. DP is the factory that produces them. DP takes raw material — data — and processes, engineers and combines it to produce both internal and external products and services.

Managing this factory requires the same types of tools needed by any manufacturing facility of comparable size and complexity. The dilemma is that we have spent the last 30 years building computer and communication capacity and have ignored the building of management control processes to efficiently and effectively run the DP factory.

Typically, the management tools in place are chargeback and/or project status systems.



The reports from these tools are provided to users and management. They, in turn, are expected to understand how well DP is being managed by interpreting the reports.

However, it is a rare DP organization that has appropriate tools to measure the factory's success in meeting its "soft goals," particularly doing so using terms the line business executives can understand.

The problem

All too often, the careers of information systems executives are abruptly altered because their corporation's management is not pleased with the way the MIS function is being handled. Behind each of these upheavals are stories of computer projects that have failed; MIS costs that were out of control; users who were not pleased; poor service levels; or deadlines that were missed, extended and missed again.

In this environment, it is not surprising that MIS executives tend to have short careers.

I have identified an almost universal characteristic of organizations in which MIS executives are successful. It is that the chief executive officer and MIS executives have developed ways to objectively measure the performance and productivity of DP. Factory management data exists and is communicated as well.

In failing organizations, the CEOs tend to have only subjective feelings about DP. They evaluate the performance of MIS based on their relationship with the top MIS executive. When the CEO likes him, things go well. When he does not, things go badly.

Empire-building

An element that too many MIS executives overlook is the nature of their own department's operation. As it has grown, MIS has become, for all practical purposes, a business within a business. It provides distinct services — custom software development, data center operations and telecommunications capabilities — to a specific group of customers: the corporation's decision makers.

To change things, the MIS manager needs to make a transition from senior technician for the corporation to, in effect, CEO of his own business.

The success or failure of an MIS executive is often measured by how others perceive the job he and his group are doing.

Among other things, the transition requires the development of a management information system to report MIS and corporate productivity.

The system and associated processes must provide a balance between the planning activities that have been emphasized in the past and the control and execution functions that have been neglected. To achieve this balance, the system should first provide accurate information, in appropriate business terms, about what productivity is. For example, it should report on capacity using the number of invoices processed or dollar volume of business as the unit of measure, instead of the number of CPU processing units or accounting units charged back.

A financial services CIO developed one reporting system. In cooperation with the executive management team, he defined the critical success factors (CSF) of his function and then used this tool to communicate results to the rest of the management team.

The organization was focusing on overall productivity. Therefore, his CSFs were service level, processing capacity, cost and head-count control. Best of all, the report was only one page, used graphics to depict trends and had a limited discussion.

Understanding

The process for measuring productivity should define and manage expectations, which necessitates understanding the conceptual framework for management of the business.

In any organization, planning and control take place at different levels. The management activities within each level cover a specific time period and have a specific purpose. Three levels are traditionally considered: the control level (on a daily, weekly or monthly basis), the tactical level (covering a one- to two-year period) and the strategic level (covering a five-year period or longer).

The productivity measurement process should serve all three of these levels. At each one, it should provide the information that allows managers to quickly and efficiently find out whether the organization is executing its plans and reaching its objectives.

A distinction should be made between operational and managerial information. Operational information is typically transactional or statistical, as represented by listings of activities, problems or events. Generally, there are large quantities of operational information within organizations.

Managerial information is far less common. It is comparative, not subjective, and relates management's planning, the corporate history and competitive position.

The objectives of a productivity measurement process are the following:

- Performance. Comparative performance should be measured in business terms against some planned activity, level, event or standard. These measurements should be nontechnical enough to be included in the corporate annual report and understood by the general public.
- Quantitative. Objective criteria should be discrete and measurable.
- Accountability. Specific individuals or groups responsible for the performance should not only be identified and charged with that responsibility but also given the resources and authority to affect the performance. When management says, "Let's cut the budget by 10%," the DP executive should not just cut the budget. He should tell senior management what will not get done. If he does not, he will be held accountable when things are not completed.
- Auditability. The reporting system to support the process should be consistent and supported by detailed information. There is nothing worse than shooting from the hip on performance. Perception is reality, and if the detail is not presented, the individual with the strongest political clout will win. I know many DP executives who were right but were fired because they were caught in emotional decision making.
- Simplicity. All good ideas can be presented on a single sheet of paper. The DP executive who presents a pair of 3-in. binders to tell a user that his department is providing a 97% service level is doomed to failure. Detail is needed as a backup, but don't drown the user in useless data.
- Comprehensive. The management reporting process should be complete in scope and reflect the organization's actual activities. Most DP organizations possess excellent project management tools to tell them how they are doing on new systems development, but these tools ignore the other 80% of the business.

It is time to bring the same discipline to the information systems organization that is expected elsewhere in the corporation. This effort begins with the establishment of a comprehensive productivity reporting system that focuses on agreed-upon metrics. Such a system essentially manages expectations and perceptions.

Janulaitis is founder and CEO of Positive Support Review, Inc., a Los Angeles-based management consulting firm specializing in helping Fortune 500 corporations manage technology and change.

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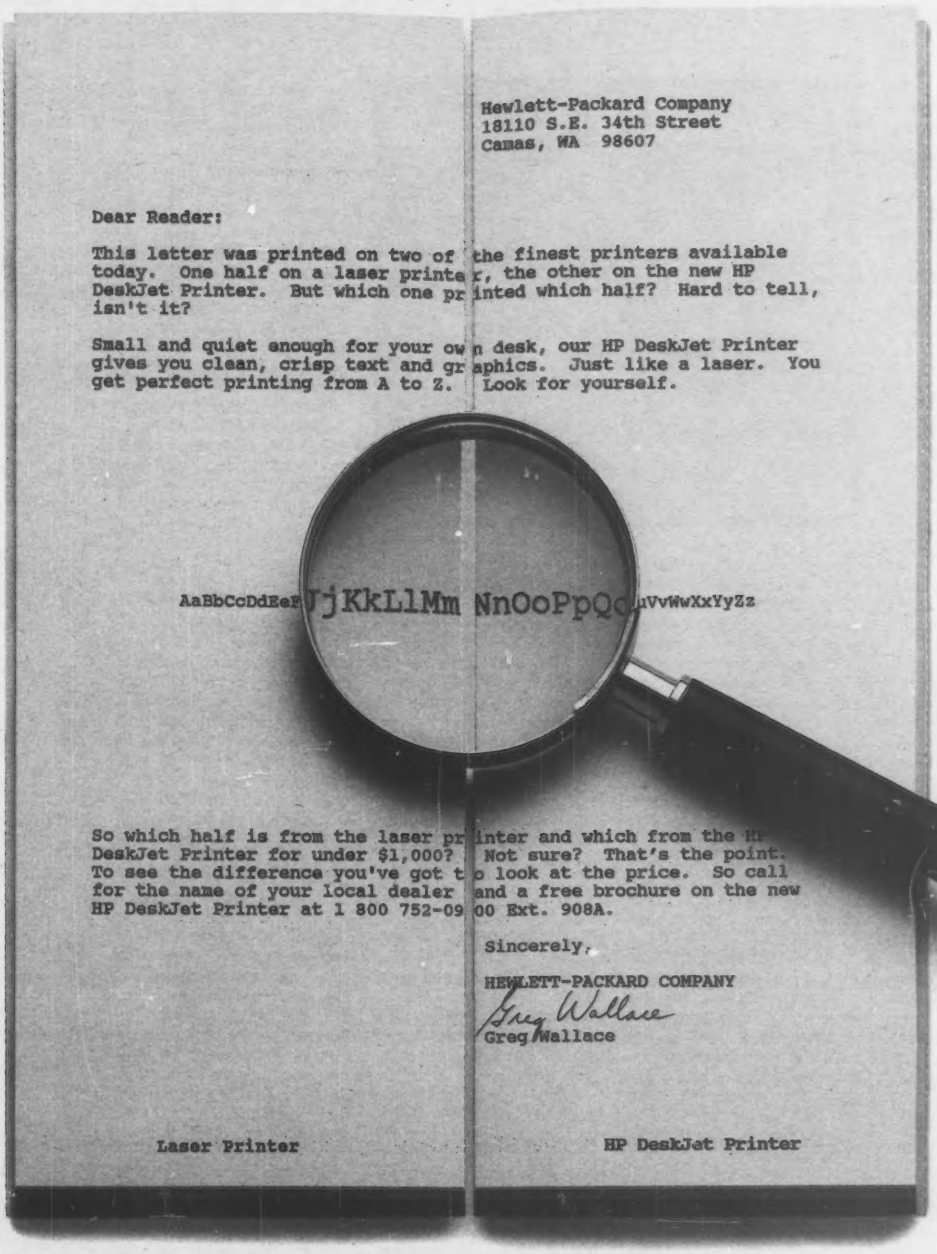
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Circle Reader Service Number 10

Computers: Lost without them and sometimes losing with them

By Gerald Sandler

An information age paradox: Without computers, we simply cannot attain dramatic productivity gains; yet with them, we seem to be losing ground.

The productivity curve in U.S. industry showed that as computerization climbed, productivity fell. The problem may not be the computers themselves. In many cases, they're doing the job they were purchased to do. Instead, information systems are suffering from a cultural problem — one common to advanced technologies.

Picture this: An Olympic runner is poised at the starting line, all set to run a 3:48 mile — only there is no track. There are no other racers, no timekeeper and no audience. The capability for a 3:48 mile is present in that runner, but not in his surrounding conditions.

When they were originally introduced, information systems were designed for very specific chores and performed them well, demonstrating impressive speed in processing the payroll, for instance. The benefits of computers came to be thought of as universal and easy to transfer to the bottom line. Organizations did not greatly change to incorporate the new technology — in fact, they planned to stay the same, if they could.

But actually, computers demand a significant adjustment in work culture. In many cases, people are simply unaware of the specific changes needed. And when they become aware, they cannot conceive of how the changes might be brought about.

The culture of tasks

In general, the American work culture is oriented toward individual tasks or task groups, rather than the unified job of an organization, which is the production of a product or service. Managers emphasize the tasks without much questioning their value, the way they are being performed or their relation to all the other tasks involved in producing the final product or service.

This fracturing permeates the information flow at most companies. To accomplish individual tasks, many managers think employees need only know what is necessary for that single purpose.

But information from manufacturing, finance, purchasing and even marketing might be helpful to the designer at work on a new product. Without that information, the design engineer's vision is circumscribed by his immediate tasks and his part in the overall process. Without knowing it, the other departments are also circumscribed, and they are not able to fully support the designer, just as the designer is relatively unable to support their departmental goals.

Systems offer a perfect answer to breaking down autonomous task barriers, but they have not generally been designed or used that way. Instead, the way companies use computers reflects the culture of tasks. The computing paradigm for many years has revolved around applications: The more applications, the more islands of automation.

Data specialists

This syndrome is not at all strange, considering how information systems are designed and selected. They are built by data specialists, who, in most cases, do not have the end user's corporate need directly in view. The specialists solve interesting technical problems.

In the local task-oriented user organization, data professionals are hired to manage all of this computerization. They, like the manufacturers' specialists, can only solve the problems they recognize and that are brought to them — and only in the terms in which the problem is posed.

Management should supply the corporate philosophy or focus, which is the single vision of needs and goals. Management does not do this, because it is locked into the mentality of individual tasks and need-to-know information flows.

Meanwhile, systems proliferate, productivity slides and everyone concerned looks on quizzically, saying: "Wasn't this supposed to be the answer?"

Lacks critical mass

We may all possess more computers than we need, but probably not more computer power than can be usefully deployed in the battle for productivity. The problem is, our computer power is disorganized, broken into islands and, thus, often fails to reach the critical mass.

In reality, tasks are not as sharply defined or delimited as we make them seem. By artificially setting their borders, we place limits that interfere with getting the job done.

Consider a new product development project in a company. One group's task is generating plans, another reviews and alters the plans, a third reviews the plans of the second group and so on. This interdependent work proceeds sequentially in a process of iteration that strives for a final, approved design.

Technology requires a culture that can give it maximum implementation.

Because computer specialists still do not take iteration sufficiently into account, the process usually requires passing paper documents back and forth. Preparing and distributing the documents introduces delay and possible error; further delay and error are inherent in each group's review and alteration process.

This development process is slowed purely for technical reasons: Computers are not prepared for iteration. Even if they were, the different parties in the project might not run interoperable systems. One group likes IBM, the other Digital Equipment Corp. There goes your productivity.

Finger in the pie

Consider other groups in the company not directly involved in the development task but vitally interested in it. Manufacturing is concerned with how adaptable the design is to existing production methods vs. the potential need for new methods. Finance is concerned with costs. Purchasing is concerned with supplies and marketing with product acceptance and pricing. Even sales promotion is interested in the new product's competitive features.

The best conceivable result would be achieved if all groups were considered from the start as part of the development task and gave direct input into the project as needed, while it unfolded.

Today, even subgroups within a design group inadequately communicate. They find out only during the drawn-out iterative process — or even later — whether or not they are working at cross-purposes with other groups.

For adequate communication within and among groups, MIS needs to put two new elements into place. One, in large measure, already exists but has not been properly used, which is an on-line real-time interactive information system with a shared data base. The other is the dedication to exploit this resource.

The man in the loop

It is management's job to open up the boundaries of tasks and put interactive information systems to maximum use.

Continued on page 32

WARREN GEBERT

Sandler is senior vice-president at Grumman Data Systems in Woodbury, New York.

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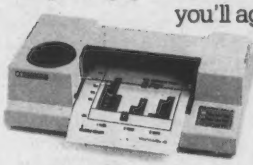

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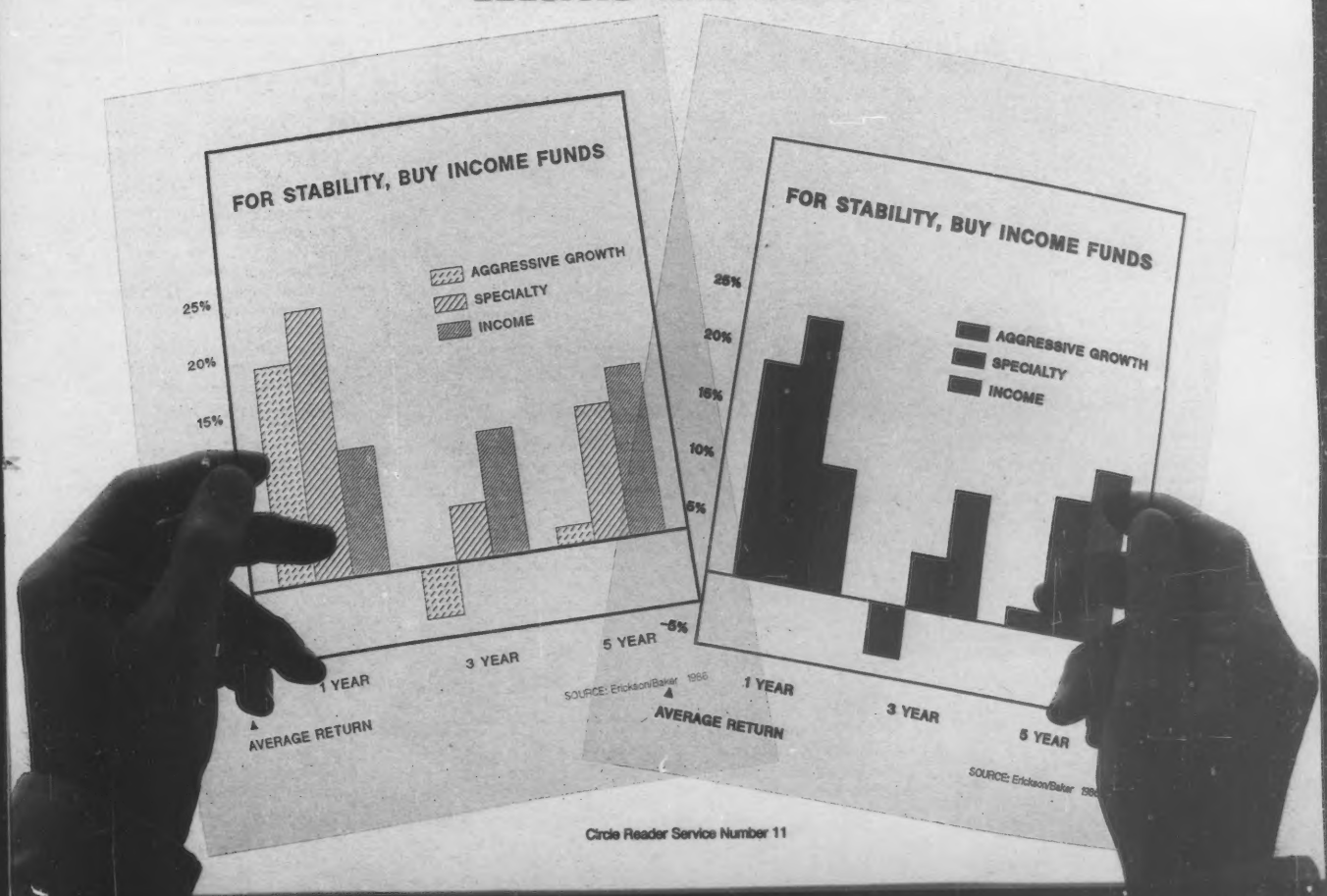

Continued from page 30

In the past, cooperating groups could get some of the information they needed via meetings, paper documents or the phone. All of these methods take time, and the person requesting the data can still be confronted by the old need-to-know question: "Why are you asking?" It's a sure sign that that turf is being protected.

Interactive information systems speed up the process, establish the right to access useful information and require no "fishing" among possible information sources — no day-to-day breaking down of barriers to the information flow. The old barriers might have made sense in a time when it was difficult or costly to bring everyone on a project up to high knowledge levels.

In the interactive model, the user is surrounded by a supportive information environment and is more able to be an effective "man in the loop." Computers are thus freed to do what they do best — process and move information, which becomes a key factor in improved productivity.

New managers

Most task team managers are more experienced in management as a process than they are in the details of the tasks they manage. However, this focus is no longer sufficient when interactive information systems are used to increase efficiency. Each manager must now take on some knowledge from all the members of his teams, and he must also share his own knowledge with them.

The manager is now charged with knowing not only more about his own group's activity, but also about the activities of the other interested departmental groups. He helps determine the distribution of this input to his group and the output to other groups.

Management's job in this model is similar to its past function although more extensive, both horizontally and vertically. Its function is dynamically located at the critical juncture of teams, tasks and information systems.

In controlling the task process, the manager relates horizontally to top management. The manager relates both horizontally and vertically to his task team and to cooperating task teams, which are now interactively connected.

The operating task team — for example, development engineers using a computer-aided engineering tool — would now work interactively with computer-integrated manufacturing, computer-aided logistics support and computer-aided financial management.

Getting involved

Through departmental management, top executives also step more directly into the process. Top management can make a crucial contribution: encouraging growth and use of the entire system.

The new manager must be a leader with a participatory style. He is something like a battle commander — not an expert in every area, but knowledgeable in all areas and dedicated to leadership.

Even today, computers are still seen as merely faster hands.

The members of the task teams now share, interactively, management's thinking and the thinking of other groups. The direct results can be twofold: teams give better input to a task in progress, and teams identify more strongly with tasks and the overall goal of tasks — the profits of the organization.

Task team members are immediately elevated by their new role. They now share, interactively, management's thinking and play a role that is operational and decision-making at the same time. In addition, they have more scope and responsibility, which enhances their role in their own eyes and in the eyes of the organization.

Payoffs

The real boost to productivity comes in the work processes themselves. Waiting is drastically reduced by the speedy exchange of data. The work process is faster, and products are developed more quickly and potentially at a lower cost.

Team input means the final product contains the highest quality-to-cost ratio — an unbeatable combination for competitiveness.

For example, long before the product is ready, manufacturing is aware of the specific production needs it will entail and has input manufacturing parameters for consideration in the design loop.

Manufacturing time can be reduced, because the manufacturing process can be ready much closer to the completion of product development.

Technology is critical for growth. But technology is not fully useful if it is bent in ways for which it was not designed.

Even today, computers are still seen as merely faster hands. Managers need to start seeing them for what they actually are: information tools producing data that must be spread far and wide for them to have an effect.

By bending information systems the way they were designed to go — not just processing information, but *moving* it — we can begin to rescue productivity from the slough into which our task-oriented culture has pushed it.

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Circle Reader Service Number 12

Optimizing the system by maximizing the people

By Joanne Kelleher

There are many paths leading to improved efficiency in system development. Oscar Jones Jr., development center manager at Ashland Oil Co. in Lexington, Ky., knows one reliable approach. First you select the right kind of people, he says; then you steer them into an environment that permits undiluted concentration.

John Miller, chief information officer at the Williams Companies in Tulsa, Okla., takes a different route, using a fourth-generation language and related tools in conjunction with a host of internally developed data bases and program shells and following the users' lead.

Jack Crawford and Bill Baldwin at the Hartford Insurance Group suggest using a broader approach, one that encompasses maintenance programming as well as development.

Boosting the efficiency of software development and maintenance is a common goal these days. "Even people who didn't see it as a critical issue before are starting to wake up," says Chris Kemerer, assistant professor of management science at the MIT Sloan School of Management in Cambridge, Mass.

There is no single starting point or established course for this kind of effort. Organizations are finding entry points at all stages of the system development life cycle and utilizing a wide variety of techniques to push their development groups in the direction of productivity.

If there is a common thread among the campaigns now being waged, however, it is that they do not typically begin or end with tool sets, Kemerer says.

Kelleher is a *Computerworld* senior editor.

Nationwide Insurance's *Meeks*

JEFF HINCKLEY

Times change

"One thing that I have noticed is that many of these attempts involve some kind of organizational change," Kemerer says. Most commonly, that change takes the form of a newly created staff function to handle tasks such as technology research, pilot testing of tools, metrics collection and quality assurance. But in fact, a number of organizations are going far beyond that level of alteration.

Ashland Oil, for example, not only organized its system development support activities into a formal development center two years ago but also added some novel extras to its version, which it calls "Development Center Plus."

In addition to staffers who recommend methods and techniques, provide training and serve as consultants, the center employs five individuals in less traditional roles — three technical writers, a librarian and a support clerk. These people, Jones says, perform tasks that the programmers and analysts were once required to do. "What we are trying to do," he explains, "is to optimize our use of programmer and analyst expertise by allowing them to concentrate on what they do best and what we hired them to do."

Ashland Oil's *Jones*

DOUGLAS FOWLEY

The development center librarian, who is professionally trained for that job, oversees a multimedia library, maintains all program documentation, performs on-line searches to locate information about new tools or productivity aids and publishes three newsletters, including a digest of relevant articles.

The support clerk maintains all the remote printers. He also delivers the output, along with the mail, to the programmers and analysts at their desks.

This isn't empty coddling, Jones says, but a verifiably effective way of improving productivity. "We have a project accounting system that estimates and tracks time spent on documentation, so we know that in that area alone, we have been able to cut the time expenditure in half.

"Besides," he adds, "in that reduced amount of time, we are producing better and more consistent documentation."

The payback from the services of the librarian and the support clerk are a little tougher to quantify, Jones admits, although he is sure that they are now picking up information on development tools that would have been missed or overlooked before.

Then, too, there are such important immeasurables as job satisfaction and motivation. There is absolutely no way of figuring out how much the Plus part of the Development Center Plus has to do with it — as opposed to technical support, new tools and techniques or just the quality of the development staff members themselves. But clearly, some combination of things has caused output rates to double over the past two years. "Two years ago we were producing at around one function point per 18 hours," says Jones. "Now we are around one every nine hours."

The state of software development represents a significant obstacle to effective use of data.

In other cases, the structural changes that system development organizations are undertaking have more to do with cutting the distance between themselves and the business organizations they are supporting.

Kemerer has observed that there is a strong correlation between belief in the strategic importance of information systems and active efforts to improve system life cycle productivity. Once you have accepted the validity of that concept, he says, it doesn't

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take long to realize that the current state of software development represents a significant obstacle to effective utilization of corporate data.

It's commonplace

At Pacific Bell, the idea of reorganizing the information systems community so that applications are developed more directly out of business plans hardly seems new at all. "It's not exactly a radical idea anymore," says Mac Patrick, staff manager in the Systems Development Maintenance Environment within Information Systems Planning. "Two or three years ago, it was still just a concept here, but these days, people are making it work. We are building new infrastructures to support the effort, and our organizations are changing to support that."

Patrick says the information systems structure has been rearranged to conform to changes in business applications.

Groups have been formed to develop information models and create data bases from business plans and to assess the viability of business planning ideas in terms of existing technologies and applications architectures. In fact, Patrick's own group is an outgrowth of this change process.

> **"I don't believe in getting into extensive documentation or design specs."**
>
> *John Miller*
> *The Williams Companies*

"Our job," he says, "is to deal with these issues in the context of development and maintenance environments across the organization." What that means is developing baseline standards and guidelines for system development, project management and quality assurance that can be adapted and applied by individual systems departments.

Because one of the corporate goals is to foster decentralization and grass-roots independence within the information systems organization, the mandate of the Systems Development Maintenance Environment staff is to support developers with recommendations and resources rather than to implement or enforce changes within departments.

Patrick says a number of development projects that were in serious trouble for a time were eventually turned around through the incorporation of recommended practices, such as quality assurance planning and walk-throughs.

Ratio reversal

Miller of the Williams Companies has hard numbers to define the success of a sweeping reorganization within his firm's information services organization, which has been achieved during the past four years.

To begin with, he says, the ratio of development to maintenance has been drastically altered. "In 1984, only 25% of our activity was in development, and 75% was in maintenance. Now, 85% of what we do is development and 15% is maintenance."

Miller says this reversal of the traditional pattern was absolutely necessary in order to keep the information services organization aligned with the corporate business units.

Since the beginning of the decade, he explains, the Williams Companies has undergone a radical transformation. During that time, the $2 billion corporation has jettisoned four of its companies, adjusted to industry changes caused by deregulation and diversified out of its traditional field of transportation, moving into telecommunications as a fiber-optic private-line carrier.

Just keeping pace with what had happened in the traditional lines of business meant either drastically modifying or rewriting a store of applications that represented an investment of $25 million to $35 million. Added to that was the necessity of creating an entirely new support structure for the new fiber-optics company.

Miller says the information services organization has managed to accommodate all of this, including a total rewrite of all the traditional applications when it decided that course would be more cost-effective than modifying spaghetti code.

It used a suite of development tools from Applied Data Resources, Inc. in conjunction with an internally developed constellation of tools and techniques that ranged from object-based programming shells to a progressive prototyping procedure. What's more, it has managed what amounts to roughly a ninefold increase in development with only double its original number of developers.

Impressive as those numbers are on their own, they do not fully reflect the resource efficiency that has been achieved. What the numbers don't take into account is the fact that by using ADR's Ideal fourth-generation language in conjunction with programming shells, the Williams Companies' information services organization has given itself the flexibility to hire new personnel straight out of college and count on turning them into productive developers after only 10 days of training.

Of course, other companies hire programmers straight out of college without using either fourth-generation languages or special, easy-to-use programming shells. At Ashland Oil, for example, where the majority of programming is done in PL/1 and Cobol, many of the newly hired

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are also recent college graduates because, as Jones explains, "we are more interested in the ability to grasp concepts quickly than we are in experience with a particular tool or environment."

The difference, however, is that Ashland and most other companies that take the same course are not facing the same imperative for fast ramp-up to volume production or trying to combine the programming and analyst functions, as is the case at Williams.

Title distinctions such as programmer and analyst become irrelevant when you do away with extensive design specifications and documentation, Miller says. If development is approached as a process of quick and repetitive prototyping with full user involvement, the phases of design and programming become one operation.

The aim of accelerated design is to foster user involvement in projects and eliminate mid-process changes.

"It is probably a personal quirk of mine," he says, "but I don't believe in getting into extensive documentation or design specs. I think that the biggest reason there is such extensive documentation in so many places is that information systems people want to be able to protect themselves — want to be able to go back to the users and point a finger and say, 'You see, it's your fault.' "

Such an adversarial relationship is antithetical to the systems development approach at Williams. There, users head up all project teams, which typically consist of an even mix of users and developers. Most of the organization's six development teams are actually based in user, or "client," departments. "We operate as a profit center, charging back all costs to the users," Miller says, "so they really own the projects, and we function as facilitators, or subcontractors."

Instead of hefty documentation, Williams relies on fast and, if necessary, iterative prototyping based on its own version of group techniques for rapid development. Many companies have already introduced some such element into the front end of the development process and many more report that they are considering such a move.

There are a number of proprietary accelerated-design techniques now on the market, the oldest and best known being JAD from IBM. There are differences of style and approach among these products.

The goals, however, are the same for all: to foster user involvement in and ownership of the development project, define the requirements and the scope of projects at the very beginning of the cycle and eliminate avoidable mid-process changes.

Clearing the way

BHP Petroleum America, Inc. in Houston has been using JAD for about six months, according to Will Morse, the firm's manager of production systems. Although it is still a little early to tell, he says, his impression is that the major benefit of the technique is not so much the help it provides in development as the way it smoothes implementation. "If users have a chance to formally participate, it helps with acceptance of the product. No product is ever perfect, but people who have had a chance to develop some ownership are more willing to work around what you can't cover."

CINDY CHARLES

Pacific Bell's *Patrick*

Others might have more need for the access to user information that accelerated design methodologies can provide, Morse notes. At BHP, that part of the process has already been addressed through structural changes that bring developers into close and continuing contact with users and their needs.

Some time ago, BHP reorganized its information systems departments to function as support groups for specific business units. That arrangement, Morse says, has allowed programmers and analysts both to get to know users on a long-term basis and to develop a thorough acquaintance with the environments for which they are creating applications.

At Nationwide Insurance in Columbus, Ohio, direct contact with users is not easily achievable, which is one reason that Paul Meeks, manager of technology research, is anxious to bring in JAD and some kind of front-end computer-aided software engineering tool. "We have real difficulty in

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our organization really talking to people who actually perform the functions and getting those intitial specifications nailed down," he says.

By formalizing the contact process, JAD could, Meeks believes, both lessen the time involved in extracting information and help to filter input. "Too much of the time, now," he says, "we are working through the back door — through some kind of user representative or management official — and don't get the right information."

Front-end analysis and design tools are high-interest items, Meeks adds, because without them analysts are forced to work in what amounts to an antiquated environment, and the result is insufficient data diagramming and data flow modeling.

PC development tools "support a graphics capability that would drag a mainframe to its knees if many people tried to use it."

Paul Meeks
Nationwide Insurance

"Up-front analysis tools would make the whole process easier," he says. "I'm talking about things like Excelerator [from Index Systems in Cambridge, Mass.] and some of those design tools that allow you to sit down and mechanically define systems and make quick and easy changes."

One tool that is already in place at Nationwide and having a positive impact on system development efficiency, according to Meeks, is a project management tool called Project Management Workbench (PMW) from Applied Business Technologies. Before this tool was brought in to help with planning and tracking of project schedules, he says, projects were often done without benefit of any schedule updating after the initial planning phase.

"In the past," Meeks comments, "project people would draw up very extensive plans and very detailed Gantt charts at the outset of a project without knowing whether the schedules they were using were really valid or whether they could be coordinated with other projects going on in the organization in terms of resource demand. Two weeks later, they would be out of date and of no more use to them."

PMW allows developers to update their schedule dynamically, he says, and in the event of changes in variables — such as sudden illness or an unforeseen conflict with another project — to play what-if games in search of secondary options.

"I can't give you any hard figures on what it saves us," he says, "but I know that if you looked at the dollar impact of missed deadlines and delays of product to market, you would be getting into some big numbers."

Tightening support

Nationwide is also in the mainstream of another trend in system development, which is the pulling together of a central full-service support organization to meet the needs of increasingly distributed application developers.

Roughly a year and a half ago, the company folded up its existing Application Development Center and replaced it with an enhanced structure that is made up of four divisions reporting to the director of technology research. The four divisions are Meeks' own research group and others for development, deployment and support of systems.

The territory that these service types have to cover is also starting to expand. According to Meeks, the company is planning to migrate the application development process to personal computers and local-area networks in the near future. Several pilot projects are already under way in that environment.

"We are looking at establishing a development platform based on the Token-Ring and the workstation and all the supporting software," says Meeks. "We are also working on figuring out the most efficient way of transferring data and source code back and forth from the central host. IBM 3270 emulation has not been the speediest, which is why we are looking at Token-Ring attachments and supporting software that allows you to do data extracts and download packed data easily."

Some developers are already working on PC workstations, using development tools such as Excelerator from Index Systems, Inc. in Cambridge, Mass., and VS Cobol Workbench from Micro Focus, Inc. in Palo Alto, Calif.

Their experience so far has been positive enough to convince Meeks that PC development tools are superior. "They support a graphics capability that would drag a mainframe to its knees if very many people tried to use it."

'More consistent'

But graphics is not the only benefit Meeks expects to realize from widespread use of networked PCs for development work. "We expect that it will give us a more consistent response time, eliminate downtime that extends over many programmers and provide us with an incremental growth ca-

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pability," he says.

Even in organizations that have no intention of moving into a LAN environment, sharing plays a significant role in efforts to enhance development productivity.

At BHP Petroleum, Morse uses Core, a product from American Management Systems, Inc. that is essentially a set of screen and VSAM file-access routines to create a fund of shared code, thereby eliminating a significant amount of redundant programming of common routines and call.

"What we wind up writing is only the unique code," Morse says, "things like the edit checking or the combination of calculations. Core will copy in all the common code, which can amount to an enormous number of routines and calls."

Just browsing

And at Ashland Oil, the development center group recently organized existing modules of reusable code into a library system that uses a relational data base management system. "We've had reusable modules in the shop for quite a while," says Jones, "but they weren't used that much because nobody had ever really emphasized their use, even though they represented an excellent productivity advantage."

Now, he says, both the idea and the code are very visible. "All the programmers have to do is query the tables and find out what modules are available to do what functions in what language," Jones comments.

The maintenance phase of the system development life cycle represents another obvious — but infrequently addressed — productivity improvement opportunity. Most companies are aware that maintenance consumes a disproportionate amount of information system resources and that its share is growing by the year. However, few firms have yet attempted to tackle it directly.

The long haul

The Hartford Insurance Group is an exception. Starting at the end of 1984, with a proposal that maintenance productivity be addressed before it took over the entire operation, the organization moved ahead to create an Application Maintenance Center (AMC) that boasts a support staff of 45.

The aims of the AMC were to set up a baseline measurement and tracking system, provide an ongoing quality check on existing Cobol code and set up processes and tool sets that could be used for both cleaning up and rehabilitating substandard programs.

These efforts, according to Crawford, vice-president of information management, and Baldwin, a system consultant for the AMC, have allowed the company to halt and, to a large extent, reverse the process of deterioration in existing code. In addition, he says, they have provided the means for catching inefficiencies in both newly created programs and external packages that are being considered for purchase.

The effort is far from complete. On the basis of their scores when subjected to static analysis, 11,000 existing programs were targeted for some level of what the company calls "renovation," and approximately 4,000 have actually gone through the cleanup process. Even at this point, however, the benefits are starting to show.

Crawford estimates that even minor, or "quick-trip," renovation of a program produces a 10% gain in maintenance efficiency, while more extensive restructuring, such as module splitting and renaming, may often result in as much as a 25% improvement.

On an immediate basis, Crawford says, these measurement and standardization activities have "allowed us to gain control over our data." Longer term, he says, what is being built is a proper platform for reverse engineering and the creation of a corporate repository of design data for reengineering applications.

At the Hartford, a variety of tools including both internally developed aids and commercial ones such as Language Technology, Inc.'s Recoder are integral to the productivity enhancement effort. Here, as at other organizations, however, the emphasis is on generic concepts of measurement and process, rather than specific development aids.

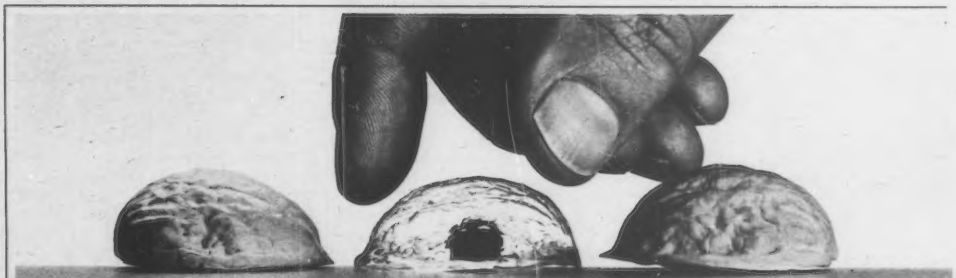
In fact, the vocabulary and theories that many organizations are applying to productivity efforts in system development are drawn directly from the tradition of manufacturing quality control.

The power of quality

At Unisys Corp., for example, Dean Lee, director of quality and productivity for the firm's Systems Support Group in McLean, Va., based his organization's Quality/Productivity Improvement Process on the system that has been advocated by quality expert Philip Crosby, which includes rigorous definition of requirements and an educational effort designed to break down the belief system that says errors or defects are inevitable.

For measurement, Lee chose not to use narrowly defined standards such as lines of code produced or errors per line of code but to work instead with a system called The Objectives Matrix, which he found at the Oregon State University Productivity Center and adapted for use in a system development setting.

"It is a good tool in any environment," he says, "and particularly well-suited to a service organization, which is what system development really is."



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Building a better metric

By Capers Jones

Most MIS producers are less than 75% efficient: End users find 25% or more of all bugs.

Imagine yourself as a runner out on a track training for the Summer Olympics in South Korea. What would you think if your coach said, "You're going to have to train hard to get faster. Of course, I'm not sure how fast you have been running, since I don't use a stopwatch."

Sound a little strange? Your coach continues: "You'll be competing in events from the 100-meter dash up to the 5,000-meter run, but I don't believe in measurements, so I'm not sure exactly how long that is on this track."

He concludes: "I want you to practice until you improve by 20%, but I'm not sure how fast that is. It should be an easy goal to reach, though, because I bought you new track shoes that the salesman says will improve your speed by 50%."

Such a conversation could never happen in real life, because no track coach could succeed without measuring his team's performance. Yet project managers expect to do just that every day in software development departments.

The traditional "lines of code" metrics were so imperfect and paradoxical that they simply could not be used for serious economic studies.

What's more, without a reliable metric for determining the output of software projects, many companies also did not bother to keep accurate records of staffing, schedules or effort expended. In project tracking systems used by major corporations, errors and omissions of 30% to more than 50% have been the norm. Unpaid overtime, user costs, project redirections, managerial effort, support costs and overhead activities such as integration are typically not tracked.

Out of the dark ages

In 1979, the software measurement situation began to improve. IBM's A. J. Albrecht introduced Function Point metrics, and for the first time, the economics of MIS projects could be measured precisely.

Function Points are artificial metrics similar in concept to the Dow Jones industrial average. The Function Point total for a project is derived by a weighted formula that includes five items:

- The number of inputs to the application (forms, screens).
- The number of outputs from the application (reports, screens).
- The number of inquiries end users can make.
- The number of logical data files updated by the application.
- The number of interfaces to other applications.

To measure a program, the software developer counts these five items and multiplies the total by weighting factors that adjust for complexity. The Adjusted Function Point total then becomes the economic unit of measure for that application.

The advantage that Function Points bring to a software project is that they are mathematically consistent — they do not behave in strange ways, as the lines of code metrics do. The old metrics were mathematically perverse in that they sometimes moved in the opposite direction of real economic productivity. And in fourth-generation languages, query languages and nonprocedural applications such as spreadsheets, there may not be any lines of code to count.

The older metrics also focused attention on coding, which is no longer the dominant activity of software developers. Large MIS projects often devote a higher percentage of resources to requirements and design paperwork, meetings, discussions and defect removal than to coding.

Setting measurable goals

Function Points are not the only elements that should be measured or targeted, of course, but they are the heart of a modern software measurement system for MIS.

The following goals stem from observations of what leading-edge companies are actually able to accomplish in 1988. If your company's output matches or surpasses these goals, then you have achieved considerable success and can be justifiably proud of your performance.

There are four key areas in which setting measurable goals is most important: quality, development productivity, maintenance productivity and morale, or the work environment.

Software quality is important not only because of the need for reliable systems but because defect removal is sometimes the most expensive part of building software. There are four major software quality goals; if your enterprise exceeds them, you are doing very well indeed.

Fewer than five user-reported defects per 100 Function Points per year. Achieving this goal would place you in the top 1% of U.S. companies. A "defect" here refers to a bug that causes the application to either stop or produce incorrect results. Ordinary and trailing-edge firms report closer to 15 or more user-reported defects per 100 Function Points per year.

High "excellent" rating. Not only do leading-edge enterprises carry out annual user satisfaction surveys, but when they do, their end users give critical applications 90% or more "excellent" votes.

More than 95% cumulative efficiency in defect removal. "Efficiency" in this case is defined as follows: In the course of developing software, your staff will find a certain number of bugs. In the first year of production, your end users will find a certain number of bugs. When you add these two bug totals together, your staff should have found 95% or more of all bugs, leaving 5% or fewer for the end users to find. Achieving this rate will place you in the top 1% of U.S. companies. Most MIS producers are less than 75% efficient: End users find 25% or more of all bugs.

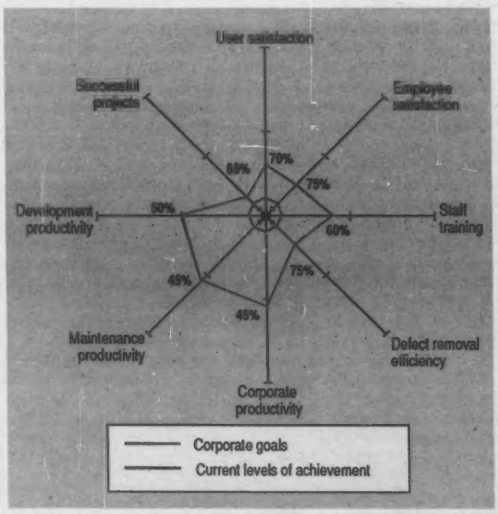
No error-prone modules in any production system. Bugs are not randomly distributed through the code of large systems. They tend to clump in a very small number of places, called error-prone modules. Your goal should be to eliminate all error-prone modules — modules that contain more than 25 bugs per 100 Function Points — in your current applications and to prevent them from occurring in the future. This goal can be achieved: It means conducting full design and code inspections.

The enterprise log

Productivity can be measured at both the project and enterprise levels. It normally registers much higher at the project level, be-

CLOSING IN ON THE GOAL

A Kiviat graph can clearly show progress among multiple parameters of a software development project



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Jones is chairman of Software Productivity Research, Inc. in Cambridge, Mass.

cause at the enterprise level, factors such as canceled projects and indirect staff must be considered. Again, observations of U.S. MIS departments lead to the following goals:

An average of more than 15 Function Points per staff-month on major projects. Ordinary Cobol applications produced using traditional methods and unsophisticated tools seldom achieve productivity rates greater than five Function Points per staff-month. If you churn out more than 15 Function Points per staff-month on major projects — those greater than 500 Function Points in size — you are doing very well indeed. The staff included in the measure should be all workers on the project: analysts, programmers, technical writers, quality assurance workers and first-line management.

More than five Function Points per staff-month in net annual software productivity. Each year, your organization will deliver a certain number of Function Points to your end users. Large enterprises may deliver more than 10,000 Function Points annually. If you divide your total delivery by your entire staff (all direct personnel, management and indirect staff), what is your annual rate?

Typically, this rate will be only about one-third as high as the rate for individual projects, because it includes time spent in training, slack time between jobs, vacation time and time spent on projects that are not delivered.

Fewer than 5% canceled projects. Canceled projects are a source of negative productivity. Effort is expended, but nothing is delivered. Some companies may cancel as many as 25% of their major systems.

Keeping up on upkeep

More than half of the programmers in the U.S. are working to maintain and enhance existing applications. Therefore, maintenance goals rank right up with development goals in importance. Here are some specific goals:

More than 1,500 Function Points per maintenance staff member per year as the average assignment. If you divide the size of your production library of current applications by the size of your maintenance staff, you will create an interesting metric called the "maintenance assignment scope." This figure is the volume of current software for which an ordinary maintenance programmer is responsible for handling defect repairs and minor enhancements.

If you have a library of aging, unstructured applications with high complexity, the maintenance assignment scope may be less than 500 Function Points. If your assignment scope is greater than 1,500 Function Points, the implication is that you are moving in the right direction — toward structuring your programs soundly.

More than 10 Function Points per staff-month as the average rate of productivity on major enhancements. Productivity rates on enhancement projects are normally lower than rates on the same size development project, so a different goal is needed. Enhancement productivity is related to the structure and stability of existing software.

"Bad fix" rate lower than 2.5%. Each time an existing application is updated, there is a chance of introducing a bug. If the bug is the result of fixing a previous bug, then it is termed a "bad fix." You should aim for less than 2.5% bad fix injection for your applications. Companies that are working with aging and unstructured Cobol sometimes find that their bad fix rate exceeds 15%.

Personnel questions

In terms of employee morale and environmental targets, software is a human activity, and enterprises that have the greatest respect for employees usually come out on top in productivity, quality and other tangible matters. Here are three key metrics for morale:

More than 10 training days per staff member per year. Companies that provide 10 days of training per staff-year show higher annual rates for software productivity than companies that provide no training.

More than 90 square feet of private office space per staff member. Studies agree that more than 90 square feet per professional staff member is optimal for the highest productivity rates. If your staff averages less than 45 square feet, expect low productivity.

More than 90% evaluations of "good" or higher on annual surveys. Companies that take the best care of their people have the highest productivity. Companies that get more than 90% "good" marks on annual opinion surveys demonstrate higher productivity than companies that don't perform opinion surveys, or that do perform them but score low marks.

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Developing reusable software

By Howard Yudkin

Software engineering is beginning to emerge from its infancy.

This growth is spurred in part by the maturation and dissemination of basic, so-called modern programming practices. The practices are variants of structured analysis for definition of requirements or high-level design decomposition and methodologies for organized management and documentation.

The practices also reflect the evolution of programming languages with improved syntax and stronger consistency properties.

Software tools automate some features of these modern practices, facilitating their use and proliferation.

The progress that has taken place in the software engineering profession during the last 10 years means it is now possible to develop better and more maintainable software systems than in the past.

Demand soars

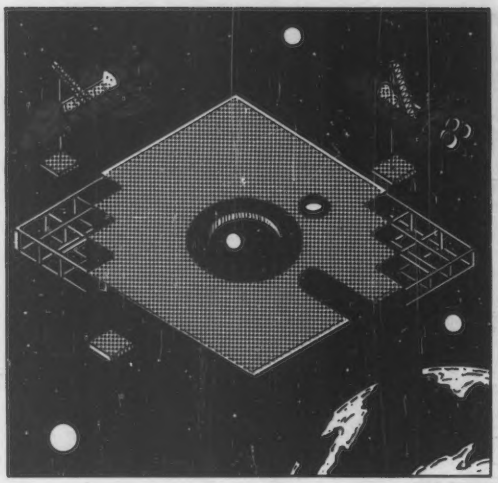
At the same time that the profession has progressed, the demand for larger and more complex software systems continues to grow. The size and complexity of projects such as the Advanced Technology Fighter or the space station dwarf any software development imaginable just a few years ago.

This explosion of demand has precipitated what many have described as a software crisis. The nation is confronted with a growing mismatch between the government's demand and the ability of the software engineering industry to meet it, even with modern programming practices.

This supply-demand gap is spurring the Software Productivity Consortium and other organizations to develop new software engineering approaches that emulate practices in more traditional engineering disciplines.

Among these approaches are techniques to identify and resolve implementation risks earlier in the development cycle and techniques to develop designs of software systems based on systematic use of standard parts. The former are referred to, perhaps inappropriately, as prototyping. Breadboarding may be a better analogy. Building software from standard parts is a form of software reuse.

Yudkin is president and chief executive officer of the Software Productivity Consortium, an alliance of defense contractors based in Reston, Va.



BRAD HAMANN

In practice, prototyping and reuse are two sides of the same coin. Standard parts allow rapid assembly of prototypes, which provide the basis for developing final systems.

The use of these techniques represents a departure from the basic "waterfall" development methods embodied in modern programming practices. But their use does not imply abandonment of the benefits of these programming practices or the tools that have emerged to implement them.

The newer engineering processes are generalizations of the older ones, but better suited to larger, more complex systems. They offer many opportunities for the development of standards to ease their journey into widespread practice. Two obvious areas in which standards are needed are the standard parts themselves and the development environments that would support their use.

Standard parts. Design based on standard parts is a regular practice in all traditional engineering fields. The use of standard parts for most systems allows designers to concentrate new effort on those areas that have novel requirements or constraints. These areas may be a small fraction — perhaps 10% to 20% — of the "modules" of the assembled systems.

To be a true standard, a part should be characterized by a "black-box" specification. The details of the part's construction should be opaque to the user; its external specification should be sufficient to characterize it.

The nation is confronted with a growing mismatch between the government's demand and the ability of the software engineering industry to meet it.

Given such a black-box approach, it would then be possible to catalog parts based on an identification system keyed to these specifications. Software parts catalogs would be analogous to catalogs of hardware parts.

Standards would be necessary to accommodate widespread use of the forms of specification and the parts identification systems. It is these "standards" that would make the parts standard.

Without a great deal of coaxing, true entrepreneurs in this marketplace can envision an industry in which suppliers build and provide the standard software parts. These providers should be able to certify their product. That is, they should be able to guarantee that the part does indeed perform as its specification states. Standard means of testing for compliance are needed for certification. This scenario also parallels that of the traditional hardware areas.

To be useful, families of standard parts should evolve. It should be possible to expand these families and break them into subsets as use demands. Thus, standards for definitions of useful families are also needed. The idea of families is not at all a new one. One need go no further than the neighborhood hardware store, where there are standard parts catalogs for every nail and screw.

There is a more relevant example in computer hardware families. The idea matured with the IBM 360 series and continues with today's reuse of processor chips.

The family concept already exists in software, too. The well-known Software Cost Reduction Method developed at the Naval Research Laboratory led to a particular set of families of specifications for software modules.

Adoption of design using standard parts would require that software engineers give up their assertion that software is inherently more complex than hardware. The complexity of software parts grows exponentially with the time span of the part's execution. Most, if not all, hardware parts have a continuum of values in any time frame.

The practice of approximating this continuum with finite families of standard hardware parts is equally applicable to software.

Prototyping. Standard software parts should have standard interface properties. These properties would permit the parts to be readily assembled and integrated into prototypes, or even deployable systems. This practice would lead to realization of the true potential of the phrase "rapid prototyping," used today as a way to describe rapid generation of user screens for management information systems.

If the interface properties of parts are standardized, it may be possible to adapt or tune standard parts to change their individual performance without disrupting their integration properties.

Much of the desired revolu-

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tion in software engineering could be achieved through ready access to standard parts. Early studies have demonstrated that improvement in system development costs of 2½ to three times are feasible in assembling single system versions using standard parts.

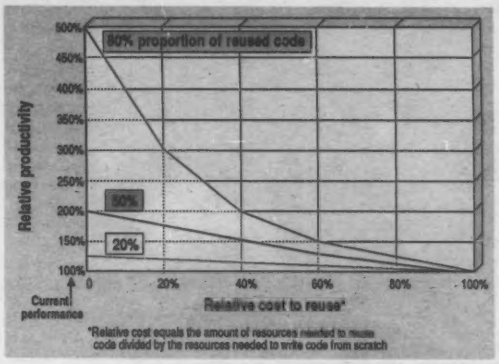
These factors account for the excess cost of developing a standard part and assume very modtools. Furthermore, these tools must communicate with each other in integrated environments.

Of particular importance is the integration of project status and planning-tool data with technical description-tool data if the prototyping process is to be controlled in a way that enhances — not hinders — project productivity.

Configuration management or version control of the life-cycle object in the prototyping process is also crucial. Engineers need an array of tools and a set of standards for the data outputs these tools generate.

MEASURING THE BENEFITS OF REUSED CODE

A high proportion of reused code, coupled with a low relative cost, results in the greatest productivity



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est levels of reuse. Given higher levels of reuse, plus the reduced number of versions required to get an acceptable final product, major improvements in software productivity will certainly be possible.

Making it happen

Engineering standards for parts will make these improvements possible. Much of the technology needed for creating standard parts already exists. Ada packages might be a source of good standard parts. Ada's generics feature permits a ready definition of families.

The separation of specification and implementation abets the desirable adaptation feature and also provides a mechanism for building collections of standard parts from previously existing software routines. In addition, the strong typing feature assists in standardizing interface properties.

The Ada package also poses an interesting technical challenge in terms of defining the right size for standard parts. A few lines, or even a single line, of Ada source code could be a standard part, but the overhead required to maintain such a small package would kill efficiency.

On the other hand, too large a package would imply a part too complex for ready reuse. Thus, some middle range of size yet to be defined is needed.

Finesse

Prototyping and reuse are complicated processes whose use requires application of automated

Standard bearers

Since it is unlikely that all the tools in a development environment will come from a single source, standards for tool interfaces, data structures and other elements in development environments must emerge.

Standard software parts should have standard interface properties.

In essence, a software development environment is simply an application to which design using standard parts applies. The tools in the environment could be constructed with standard parts that ensure adherence to the environment interface standards. Again, a major opportunity for development of software engineering standards is present.

Software prototyping and reuse are processes that not only seem reasonable, but work. Organizations are building tools that convert these ideas into practical and productive means for developing large-scale software systems.

Manufactured programming

By Robert Kendall

Software reusability has been one recent focus of the quest for improved programming productivity. With millions of man-years of programming efforts now invested in software, clearly some of it can be recaptured and used again.

Research is directed at reuse in all phases of the software development life cycle, beginning with requirements and specifications and extending through top-level and detail designs to the code itself. At the specifications level, there are special languages and facilities, pioneered by Daniel Teichroew's problem statement language and problem statement analyzer. At the design level, there are reusable templates for guidance; at the code level, there are packages of Ada or Productivity Products International, Inc.'s Objective-C.

The packages consist of objects — usually data — swathed in methods or procedures that can be applied to them. Such packages exist in source language and are bound at compile or execution time to their specific uses.

Another approach, one being followed by IBM Canada's Information Systems staff, is to use object code modules, connecting them with the aid of a special development facility. This practice produces programs composed entirely of existing parts and assemblies, or components, that the staff calls co-routines. The method, started more than 15 years ago by Paul Morrison, is still experimental, but experience gained with it is encouraging.

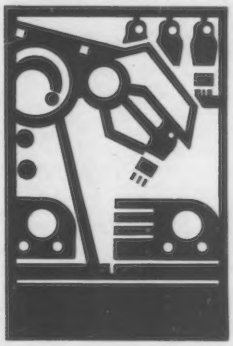
Perhaps a key feature of the new method is that programs are composed exclusively of existing parts or modules. These are assembled in a process akin to manufacturing, in which one would not stop the line to engineer a new part.

Programmers in this environment are either module builders or module users. The programming process is made exactly analogous to computer hardware development, with its chip builders and chip users.

In this, the method is similar to that of Objective-C builder Brad Cox, who speaks of software-ICs, or integrated circuits. The method differs, however, in that machine object code modules are connected and executed. The result is a program that could be described in manufacturing terms as a bill of material.

In these early stages, not every program is assembled from off-the-shelf components. Some components must be specially coded for a project, but they can be reused within the project. The effect is measurable as a percentage of delivered function.

A figure of merit is developed by dividing the number of modules coded — programmers' work — by the total number of co-routine appearances — program functions delivered. In a half-dozen projects, the percentage of specially coded modules ranged from 25% to only 1%, averaging just less than 20%.



CHRIS SPOLLEN

The bill of material rendering does not address the connections or process sequences any more than a manufacturing bill of material tells how to build an item. In fact, the connections use a data flow concept regarded as key to the method's success. The bill of material is valuable, however, in telling what components are involved and where. If defective parts are discovered at a later time, they are easily located and replaced by corrected parts. Similarly, where units are found to receive heavy use, special attention can be given to improving their performance or reducing their size.

Benefits

Practical experience with the method has proven to be of substantial value. Anticipated benefits often focus on the process itself, but this limited view results in an understatement of value that may slow acceptance. Actual experience shines a light on real benefits achieved in a broader scope — among users and maintainers as well as developers of the programs.

Among these benefits is the improved programming productivity that was sought. Other improvements occur at the specification and design levels, at which work is performed in the context of the available parts and assemblies. This is similar to computer development, in which use of chip supplier "bug books" is made to select off-the-shelf chips.

Surprisingly, performance benefits were realized in several cases. Many researchers apologize in advance for reusability performance; everyone knows that the generalization needed for reusability leads to performance penalties.

In fact, that is not always true. Given the increased value resulting from reuse, one can afford to spend more on development — the added costs are spread over wider applications.

An aid to improved performance is the special scheduler that provides the operating environment for the reusable coroutines at IBM Canada. This approach can result in increased CPU intensity while reducing elapsed execution time, which should not be altogether dismaying to a computer vendor.

Program readability and user understanding have improved as the method has produced a mapping that is more logical and closer to application function. Also, program testing is greatly simplified, a reflection of the reduced complexity. Existing catalogued modules do not need unit testing; that has been done. One need only test the connections between modules to assure their proper use.

A full review of benefits is beyond the scope of this article, but one very important one is the improved robustness and reliability of the resulting programs. In reusable functions, one can include more type checking and other data-validity safeguards than is usual in application programs, especially in simple ones. Thus, the real benefit, over and above productivity and long-run performance, is the boost to quality.

What is developing in IBM Canada is just a beginning that is only now beyond the talking stage. Nonetheless, it is encouraging that some real experience with a "parts and assembly" manufacturing approach to programming has begun.

Kendall is a research fellow at Software Productivity Research, Inc. in Cambridge, Mass., and a consultant in programming productivity and measurement.

The neglected wasteland

By Roger Philips

If software development productivity looks unimpressive, then maintenance productivity looks positively dismal. Only 10 to 15 lines of fully debugged code produced per man-day in a third-generation language is the national average for new programs. But for maintenance, the numbers are only about one-tenth as good: one or two lines of changed or added code, fully debugged, per man-day.

You can argue about the merits of using lines of code as a productivity measure, but the comparison still stands. And unfortunately, maintenance absorbs 70% to 80% of every software dollar, which means we are taking it on the chin in the largest area of software investment. The federal government alone spends more than $5 billion a year on software maintenance.

Our industrial society attacks productivity problems with automation. Yet you could probably count on your fingers the number of truly useful automated maintenance products available. While vitally important, the maintenance side of software has been a wasteland, relatively neglected in the quest for improved productivity.

And things may get worse before they get better. A recent study by the Gartner Group, Inc. in Stamford, Conn., projects maintenance to grow to 95% of the programming budget by 1990. Meanwhile, the old code gets older, more complex, more brittle and, correspondingly, more difficult to maintain.

Why the neglect?

How did software maintenance become such a wasteland? Is there some pervasive prejudice against devoting resources to it?

Hari Notowidigdo, vice-president of information systems at Wendy's International, Inc., gives three reasons:

- Managers prefer to deal with state-of-the-art technologies — associated with new systems — to bolster their careers.
- Managers too often yield to constant vendor pressure to implement new technologies.
- MIS culture tends not to reward achievement in maintenance. Ask yourself, Who ever got promoted for excellence in maintenance? Promotions go to leaders of major, successful development projects.

Through the years, this negative attitude about maintenance has eroded any infrastructure that might have helped build a base of productivity. For example, you can probably think of half a dozen systems development methodologies currently in use, but can you think of even one maintenance methodology?

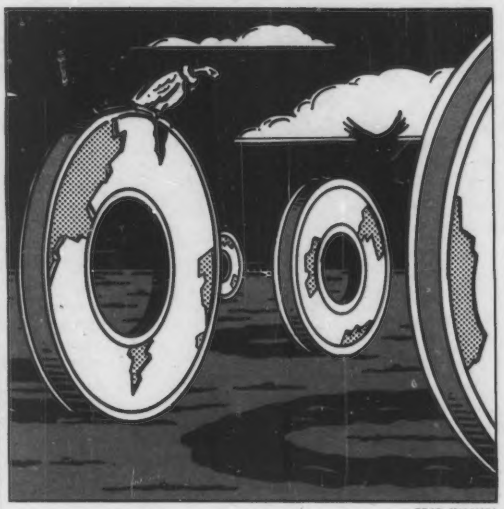
By the same token, there is little training targeted at maintenance. An informal survey I took of 130 systems professionals at a productivity conference in January showed that virtually all their organizations provided classroom training for systems development. But while those surveyed agreed that maintenance consumed the majority of their programming resources, only three said their companies had instituted any training for it. Even then, a How to Read Dumps course was about as far as the training went.

There is a continuing problem of freeing resources for maintenance. "It is viewed as a necessary evil rather than an opportunity to manage change and planned improvement," says Vaughan Merlyn, a consultant and chairman of CASE Research Co. in Bellevue, Wash. Merlyn says companies do not allocate large budgets for maintenance products and services because management does not take it seriously. "It isn't that there is a shortage of technology," he says, "but there's an excess of inertia."

Can you think of even one maintenance methodology?

Indeed, there is a shortage of good programming aids. "The vast majority of software tools are for new development," says Steve Drummond, a project manager at Hallmark Cards, Inc. in Kansas City, Mo. "The maintenance world needs tools, too."

Merlyn contends that "the potential is all too obvious" for automated maintenance tools. "The few tools out there are good, like Via/Insight from Viasoft, Inc. and Recoder from Language Technology, Inc. — both of which the users believe to be effective."



BRAD HAMANN

Viasoft President Kent Petzold adds that it is not just programming tasks but management and administrative tasks that could be addressed. Configuration management, for example, is a common problem quite susceptible to computer-aided solutions. Tools could help keep source, load and object modules in sync, coordinate screen maps and data base views and compare internal and external documentation.

Rays of hope

Despite the gloom, there are four promising developments on the horizon; each may boost maintenance productivity just in time:

- Maintenance centers.
- Targeted tools.
- Programming workstations.
- Reverse engineering.

Maintenance centers are just now coming into being. And why not? End users have their information centers. Software developers rely on development centers. Maintenance programmers could use resources and an organization of their own.

At The Hartford Insurance Group, for example, there are about 1,000 programmers, 70% of whom work full time in maintenance. Since establishing an application maintenance center, which promotes the use of such products as Recoder, Hartford experienced a 25% increase in maintenance productivity, as measured by its ability to reduce or redeploy maintenance staff.

As MIS increasingly recognizes the importance of maintenance, these centers will become as common as development centers are now.

Hallmark has taken a more deliberate approach to software maintenance than many firms. Jim Johnson, data center director at the company, implemented a tracking system that reports how many lines of code and how many function points are developed and maintained per year and per man-year.

Johnson built a history of productivity measures, which shows a slow but steady increase in the number of code lines and function points a programmer can keep under maintenance. In 1987, for example, the maintenance group was able to support 170,000 lines of code per person, up 23% from the previous year. This increase he attributes to "good testing tools and good response time."

Riding the cycle

Another promising area consists of tools that are consciously targeted at the most fertile areas of maintenance. Too many of the tools today are aimed, as Jeff Goverman of the Gartner Group puts it, "at some ethereal problem rather than on where maintainers spend their time."

Just as there is a recognized software development cycle, there is a maintenance cycle. According to a study of 25 IBM installations conducted by George DiNardo, executive vice-presi-

Philips is president of Philips Associates, a Scottsdale, Ariz.-based firm that consults in the planning, management, marketing and development of computer-related products and organizations.

dent of Mellon Bank NA in Pittsburgh, adaptive maintenance makes up 70% of all maintenance, corrective 17% and perfective 13%.

Clearly, adaptive maintenance is the highest payoff area for automation.

Research gathered by IBM's Robert Fjeldstad and William Hamlen in 1979 indicates where time is spent during adaptive maintenance: About 40% of a programmer's time is split between understanding the change and tracing the program's logic; another 28% in testing and debugging the change. Time is also spent reviewing and updating documentation.

Obviously, the best automation targets are testing, debugging and logic analysis. It is time to refocus our attention on this kind of "computer-aided software maintenance," or CASM (see story below).

Get smart

Another major development that will positively affect maintenance programming is the advent of intelligent programmers' workstations.

Mainframe-compatible compilers, data base management systems and transaction processing software for PCs from such companies as Microfocus and Oracle give programmers a private, well-controlled and highly responsive environment in which to work.

One of the most significant developments for automating maintenance is reverse engineering. Unlike re-engineering, reverse engineering means extracting the specifications of the application by processing the existing code.

The result is made available to programmers and designers in a high-level format, which allows them to better understand and, ultimately, more easily make changes to the system. They use the high-level format expressions to make the changes — either by hand or using a code generator that can be driven from the specifications.

> **Just as there is a recognized software development cycle, there is a maintenance cycle.**

Re-engineering, on the other hand, is aimed at making existing code more maintainable. Examples of these products are restructurers, formatters and beautifiers.

Tony Scott, development center manager at Indiana Bell, says that since "most systems today are not well designed or well documented, reverse engineering is the best hope of the future."

But according to Mehru Thacre, assistant vice-president at Mellon Bank, the focus in maintenance is shifting to re-engineering. Extending the life cycle by a couple of years has become the programming department's goal, he says.

Limits of logic

Reverse engineering is not yet a commercially proven technology, although several companies have announced products. There is disagreement among the developers as to how far reverse engineering can proceed. Bill Engle, president of Language Technology, who is devoting the lion's share of his firm's research and development resources to it, feels that the process can be fully automated.

The most difficult part is dealing with program logic. Language Technology's approach to that is to recognize programming paradigms, of which there are only a limited number.

Charles Bachman, founder of Bachman Information Systems, disagrees. "Totally automated reverse engineering is impossible," he says, claiming there is not enough information embedded in the code. "The question is, on a continuum from zero to 100%, where will you be?"

Bachman's approach, therefore, is to create "expert advisers," or "co-pilots," to assist professionals in completing the reverse engineering task. These products will "help people do what they already know how to do," he claims.

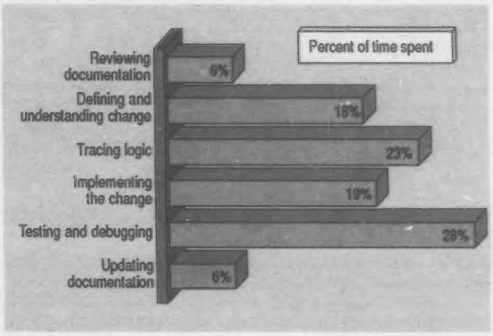
Transform Logic Corp. in Scottsdale, Ariz., is developing an expert system-based reverse-engineering product that is expected to reduce any program or set of programs to a single logical expression. From that point, specifications will be displayed graphically to aid in program understanding. Transform Logic's approach will feature simulation of proposed changes as well as regeneration of changed code.

According to Bachman, the managers most willing to invest in automating maintenance today are in financial services. "They recognize that they are really in the information products business," he says.

Mellon Bank, for example, has gone to great lengths to tailor its own programmers' workbench using a Wang VS front end from Wang Laboratories, Inc. The workbench integrates various maintenance tools while helping enforce standards.

As other industry participants begin to feel the pinch of lost competitiveness because of aging and brittle application software, they too will begin to respond to the imperative of automating maintenance.

WHERE TIME IS SPENT IN MAINTENANCE



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Rating the maintenance tools

By Roger Phillips

Which computer-aided software maintenance products should you implement? Ask the practitioner.

Twenty-four mainframe Cobol programmers and managers from maintenance groups at American Express Co., Associated Grocers, Inc., the U.S. General Services Administration and other organizations each rated the following product categories from 1 to 17, with 1 as the most desirable and 17 the least.

Some categories represent commercially available offerings, and some are still on the drawing board.

On-line products, in the order they appeared on the questionnaire, were rated as follows:

- Program tester/debugger (Ranking: 1). Permits programmer interaction with a running program during test. Supports programmer-defined traps and traces and intercepts Abends.
- Syntax-directed editor (Ranking: 10). When programs are being edited on-line, package checks language syntax, data usage and field definitions as each program line is added or modified.
- Program analyzer (Ranking: 4). Interactively traces program logic paths, both forward and backward. Reveals data usage, data relationships and dead code. Isolates and displays program components by statement type or category. Intended to help programmers understand programs and show the effect of program changes.
- Program analyzer/debugger (Ranking: 2). Performs all functions of the program analyzer above and allows on-line program editing and modification without leaving the product.
- System analyzer (Ranking: 11). Performs all functions of the program analyzer above, but at the system or library level, using not only program code but screen and data base definition information as input.
- Programmer's toolbox (Ranking: 7). An integrated system of menus by which the programmer can automatically invoke compiles, links, tests or any of the following tools; file, data base and print utilities; utilities for job control language tailoring; optimal blocksize calculation; hex and decimal calculator function; electronic mail; and telephone directories.
- Testing/debugging expert system (Ranking: 8). Diagnoses software problem types and suggests further diagnostic or corrective actions in an interactive dialogue with the programmer.

Batch products were rated as follows:

- Test data generator (Ranking: 5). Creates test data files and data bases using random data whose format is determined by the program source or data dictionary. Saves programmer time in creating or extracting test data.
- Path test data generator (Ranking: 3). Performs the functions of the test data generator above but, in addition, automatically tailors data to exercise all possible program paths, or optionally, only newly created paths.
- Test data extractor (Ranking: 6). Under programmer control, extracts applicable test files and data bases from existing files and data bases.
- On-line regression tester (Ranking: 9). Captures on-line transactions for later batch-testing use. Results of the subsequent tests — in form of screens and files — are automatically compared with original, and any discrepancies reported.
- Program standards monitor (Ranking: 16). Reports on and summarizes violations of installation coding standards for programs, systems or libraries.
- Program quality analyzer (Ranking: 15). Reports on and summarizes various industry-standard measures of complexity and maintainability for programs, systems or libraries.
- Code restructurer (Ranking: 12). Automatically recodes programs without changing function, making them conform to standards of structure and syntax. Objective is to make complex programs easier to maintain.
- Source code comparer (Ranking: 14). Compares two program versions and reports all differences.
- Source logic comparer (Ranking: 13). Compares two program versions and reports all logic path differences.
- Program structure charter (Ranking: 17). Draws hierarchical structure charts of program control flow.

Not surprisingly, maintenance programmers and their managers disagreed somewhat on priorities. Programmers strongly favored testing and debugging products, while their managers liked program analyzers.

The most inconsistency showed up on opinions regarding restructurers. Survey respondents either loved them or hated them, with little middle ground.

Quality assurance-related products were rated consistently at the bottom of the heap.

Lose fat while sleeping and deliver systems six months early!

By Tom DeMarco and Timothy Lister

Historians long ago formed different theories of value. The Spanish Theory, for one, held that only a fixed amount of value existed on earth, and, therefore, the path to the accumulation of wealth was to learn to extract it more efficiently from the soil or from people's backs.

Then there was the English Theory, which held that value could be created through ingenuity and technology. So the English created an Industrial Revolution, while the Spanish spun their wheels trying to exploit the land and the Indians in the New World. They moved huge quantities of gold across the ocean, and all they got for their effort was enormous inflation — too much gold money chasing too few usable goods.

The Spanish Theory of value is alive and well among managers everywhere. You see it whenever they talk about productivity. Productivity ought to mean achieving more in an hour of work, but all too often it has come to mean extracting more for an hour of pay. There is a large difference.

Spanish Theory managers dream of attaining new productivity levels through the simple mechanism of unpaid overtime. They divide whatever work is done in a week by 40 hours, not by the 80 or 90 hours that the worker actually puts in.

That's not exactly productivity — it's more like fraud — but it's the state of the art for many American managers. They bully and cajole their people into long hours. They impress upon them how important the delivery date is, even though it may be arbitrary. They shame people into sacrificing all and everything to meet The Deadline.

Winning and losing

Next time you hear someone talking about productivity, listen carefully to hear if the speaker ever uses the word "turnover." Chances are that he or she will not. What sense can it possibly make to discuss one without the other? Consider some of the things that organizations typically do to improve productivity:

- Pressure people to put in more hours.
- Mechanize the process of product development.
- Compromise the quality of the product.

Any of these measures can potentially make the work less enjoyable and less satisfying. Hence, the process of improving productivity risks worsening a company's rate of turnover. That doesn't say you can't improve productivity without paying a turnover price. It only says you need to take turnover into account whenever you set out to attain higher productivity. Otherwise, you may achieve an "improvement" that is more than offset by the loss of key people.

Most organizations don't even keep statistics on turnover. Virtually none can tell you what replacement of an experienced worker costs. Productivity is considered as though turnover were nonexistent or cost-free.

All too often, productivity means extracting more for an hour of pay.

The Eagle project at Data General Corp. is a case in point. The project was a Spanish Theory triumph: Workaholic project members put in uncounted unpaid overtime hours to push productivity to unheard-of levels. At the end of the project, virtually the entire development staff quit. What was the cost of that?

Productivity has to be defined as benefit divided by cost. The benefit is observed dollar savings and revenue from the work performed; cost is the total cost, including replacement of any workers used up by the effort.

We observed one recent project that was proceeding so smoothly that the project manager knew she would deliver the product on schedule. She was summoned in front of the management committee and asked for a progress report.

She said she could guarantee that her product would be ready by the deadline of March 1, exactly on time according to the original estimate. The top managers chewed over that piece of unexpected good news and then called her in again the next day. Since she was on time for March 1, they explained, the deadline had been moved up to January 15.

Productive sleep

One day, in a moment of silliness, we started clipping ads for products that claimed to boost productivity by 100% or more. Within a very short time, we had quite a pile. The amazing thing was the diversity of the means being advertised to yield big productivity gains. There were seminars, packaged programs, methodologies, books, scheduling boards, hardware monitors, computing languages and newsletters.

Going uptown on the subway that night, we spotted one final ad on the back of the *New York Post*. It read, "Lose fat while sleeping." It seemed to fit right in with the others.

We're all under a lot of pressure to improve productivity. The problem is no longer susceptible to easy solutions, because all the easy solutions were thought of and applied long ago. Yet some organizations are doing a lot better than others. And those who do better are not using any particularly advanced technology. Their better performance can be explained by their more effective ways of handling people and modifying the workplace and corporate culture.

Good or bad?

Suppose there were a foolproof productivity measurement tool and it was being applied to your people's work this very moment. Suppose the measurers came in to tell you that your productivity was in the top 5% for organizations doing your kind of work. You'd be pleased. You'd wander around the halls with a secret smile, thinking warm thoughts about your people: "I suspected they were pretty good, but this is

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BRAD HAMANN

terrific news."

Oops. The measurers have just come back to tell you that they must have been holding the graph upside down when they gave you the first report. You're actually in the bottom 5%.

Now your day is ruined. You find yourself thinking, "I might have known it all along. Who could expect to get any work done with turkeys like these on the staff?"

In the one case, you're ecstatic; in the other, despondent. But in neither case are you particularly surprised. You're not likely to be surprised no matter what the news is, because you haven't the foggiest idea what your productivity is.

You can't afford to remain ignorant of where you stand. Your competition may be 10 times more effective than you are, doing the same work. If you don't know it, you can't begin to do something about it. Only the market will understand. It will take steps of its own to rectify the situation — steps that do not bode well for you.

Motives

Work measurement can be a useful tool for improving methods and motivation as well as enhancing job satisfaction, but it is almost never used for these purposes. Measurement schemes tend to become threatening and burdensome.

All the easy solutions were thought of and applied long ago.

To make the concept deliver on its potential, management must be perceptive and secure enough to cut itself out of the loop. That means the data on individuals is not passed up to management, and everybody in the organization knows it. Data collected on the individual's performance must be used only to benefit that individual.

The measurement scheme is an exercise in self-assessment, and only the sanitized averages are made available to the boss.

This concept is a hard one to swallow for many managers. They reason that they could use the data to do some aspects of their work more effectively — precision promotion, for example, or even precision firing. Their company has paid to have the data collected, so why shouldn't it be made available to them?

But collection of this very sensitive data on the individual can only be effected with the active cooperation of the individual. If ever its confidentiality is compromised, if ever the data is used against even one individual, the entire data collection scheme will break down.

Furthermore, individuals are inclined to do exactly the same things with the data that the manager would do. They will try to improve the things they do less well or try to specialize in the areas where they already excel.

In the extreme case, an individual may even "fire" himself in order to stop depending on skills that have been found to be deficient. The manager doesn't really need the individual data in order to benefit from it.

Bureaucracy

A study conducted by Capers Jones in the late 1970s reported on systems development costs by work category. One category was "paperwork." What Jones calls paperwork is more or less mindless paper pushing, since the thinking time necessary to decide what to put on the paper is categorized as some other activity, such as analysis, design or test planning. In other words, his "paperwork" category is pure bureaucracy.

Jones concluded that paperwork is the second largest category of systems development work, accounting for more than 30% of the cost of producing a given product.

There is a depressing modern trend to make development workers more and more into bureaucrats. We know of companies in which the development groups look and feel like a bureaucratic nightmare by Kafka, and other companies in which the paperwork burden is minuscule.

Mindless paper pushing is a waste. It ought to be attacked because it keeps people from working. But our point here is a slightly different one. It is that bureaucracy hurts team formation.

The team needs to believe in whatever goal it forms around. That goal can be arbitrary, but at least it has to exist. There has to be some evidence that management believes in it.

Just telling your people that the goal matters won't be enough if you also have to tell them they should spend a third of their time pushing paper. Paper pushers can't get past the function of a SWAT team. They can't see themselves as hell-bent on success.

Quality-reduced

People don't really talk about quality-reduced products. What they talk about is cost-reduced products. But it usually boils down to the same thing.

The typical steps we take to deliver a product in less time result in lower quality. Often the product's end user consents to this trade-off (less quality for earlier, cheaper delivery).

Continued on following page

False hopes included

By Tom DeMarco and Timothy Lister

The relative inefficacy of technology may be a bit discouraging, at least in the short run, because the kinds of modifications to corporate culture we advocate are hard to apply and slow to take effect.

What seems far preferable is the coupon you cut out of the back pages of a magazine to send in with a few thousand bucks, so that some marvelous productivity gimmick will come back to you in the mail. Of course, it may not do much for you, but then easy nonsolutions are often more attractive than hard solutions.

The false hopes engendered by easy technological nonsolutions are like those Sirens that tempted poor Odysseus. Here are the seven Sirens, or false hopes, of software management:

There is some new trick you have missed that could send productivity soaring.

Response: You are simply not dumb enough to have missed something so fundamental. You are continually investigating new approaches and trying out the ones that make the most sense. None of the measures you've taken or are likely to take can actually make productivity soar.

What they do, though, is keep everybody healthy: People like to keep their minds engaged, to learn and improve. The line that there is some magical innovation out there that you have missed is a fear tactic; it is employed by those with a vested interest in selling it.

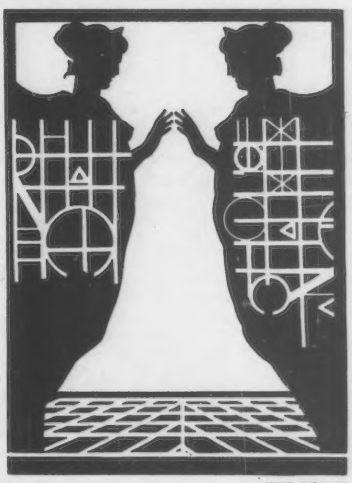
Other managers are getting gains of 100% or 200% or more.

Response: Forget it. The typical magical tool that's touted to you is focused on the coding and testing part of the life cycle. But even if coding and testing went away entirely, you couldn't expect a gain of 100%. There is still all the analysis, negotiation, specification, training, acceptance testing, conversion and cutover to be done.

Technology is moving so swiftly that you're being passed by.

Response: Yes, technology is moving swiftly, but — and here's the high-tech illusion — most of what you're doing is not truly high-tech work.

While the machines have changed enormously, the business of software development has been rather static. Cobol and Fortran, now more than three decades old, are still viable languages. Integrated data bases are still a hot topic, just as they were 25 years ago. Productivity within the software industry has improved by 3% to 5% a year, only marginally better than the steel and automobile industries.



CHRIS SPOLLEN

Changing languages will give you huge gains.

Response: Languages are important because they affect the way you think about a problem, but, again, they can affect only the implementation part of the project.

Most of what you're doing is not truly high-tech work.

Because of their exaggerated claims, some of the fourth-generation languages qualify as the ultimate technical laetrile. Using a fourth-generation language package for a given application is probably better than writing it in Cobol, but even before fourth-generation languages, most of us were clever enough to use something better than Cobol for report generation and for other ideal fourth-generation applications.

Such products are targeted at a narrow domain of applications and, hence, are not really "languages" in the general sense. That doesn't imply they aren't good products. By all means, use one if it fits the kind of work you're doing. If you get a 15% overall productivity gain, be pleased. But don't expect much more.

Because of the backlog, you need to double productivity immediately.

Response: The much talked-about software backlog is a myth. We all know that projects cost a lot more at the end than what we expected them to cost at the beginning. So the cost of a system that didn't get built this year (because we didn't have the capacity for it) is optimistically assumed to be half of what it would actually cost to build — or less.

The typical project that's stuck in the mythical backlog is there because it has barely enough benefit to justify building it, even with the most optimistic cost assumptions. If we knew its real cost, we'd see that project for what it is: an economic loser. It shouldn't be in the backlog; it should be in the reject pile.

You automate everything else — isn't it about time you automated away your software development staff?

Response: This issue is another variation of the high-tech illusion: the belief that software developers perform easily automatable work. In fact, their principal work is human communication to organize the end users' expressions of needs into formal procedure. That work will be necessary no matter how we change the life cycle. And it's not likely to be automated.

Your people will work better if you put them under a lot of pressure.

Response: They won't — they'll just enjoy it less.

But such concessions can be very painful for the developers. Their self-esteem and enjoyment are undermined by the necessity of building a product of clearly lower quality than what they are capable of.

An early casualty of quality reduction is whatever sense of team identification the group has been able to build. Co-workers who are developing a shoddy product don't even want to look each other in the eye.

There is no joint sense of accomplishment in store for them. They know that there will be a general sense of relief when they can stop doing what they're doing. At the end of the project, they'll make every effort to separate themselves from other members of the group and get on to better things.

Every defect the team found was one that the customers wouldn't find. The team was a success.

The Black Team

Once there was a company in upper New York state that made large blue computers. The company also made software to run on these computers. Customers of this company were nice enough folks, but just between you and I, the customers could be awfully poor sports about software that was delivered with bugs.

For a while, the company put its efforts into training the customers to be more tolerant of bugs. But this approach didn't work out, so they bit the bullet and decided to get rid of the bugs instead.

The easy and obvious approach was to have the programmers remove all bugs prior to delivery. For some reason, this approach didn't work too well either.

It seems that the programmers were rather too inclined to believe the best of their programs. Try as they might, they couldn't find the last remaining bugs, so they often declared the software to be done prematurely when there were still lots of bugs.

Finding the last bug was hard, but some testers were better than others. The company formed a group of these particularly talented testers and gave them the charter to do final testing on critical software before it was sent to customers. Thus was born the legendary Black Team.

The Black Team was initially made up of the people who had proved themselves to be slightly better at testing than their peers. They were slightly more motivated.

Objectivity

They also were testing code that had been written by someone else, so they were free of the cognitive dissonance that hampers developers when they are testing their own programs.

All in all, those who formed the team might have expected it to achieve at least a modest improvement in product quality, but they didn't expect more than that. What they got was much more than that.

The most surprising thing about the Black Team was not how good it was at the beginning, but how much it improved during the next year.

Some magic was happening: The team was forming a personality of its own. This personality was being shaped by an adversary philosophy of testing that evolved among group members, a philosophy that they had to want and expect to find defects.

They weren't rooting for the developers at all; in fact, it was quite the opposite. They were delighting in submitting the program — and the programmer — to a sequence that was not just a test but an ordeal.

Bringing your program in for Black Team testing was like appearing before Ming the Merciless.

At first it was simply a joke

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that the tests they ran were nasty and that the team members actually loved to make your code fail.

No laughing matter

Then it wasn't a joke at all. Team members began to cultivate an image of destroyers. What they destroyed was not only your code but your whole day.

An early casualty of quality reduction is whatever sense of team identification the group has been able to build.

They did monstrously unfair things to elicit failure, overloading the buffers, comparing empty files and keying in outrageous input sequences. Grown men and women were reduced to tears by watching their programs misbehave under the demented handling of these fiends. The worse they made you feel, the more they enjoyed it.

To enhance the growing image of nastiness, team members began to dress in black — hence the name Black Team. They took to cackling horribly whenever a program failed. Some of the members grew long mustaches that they could twirl in Simon Legree fashion. They'd get together and work out ever more awful testing ploys.

Programmers began to mutter about the diseased minds of the Black Team members.

Needless to say, the company was delighted. Every defect the team found was one that the customers wouldn't find. The team was a success.

Team spirit

The Black Team succeeded as a test group, but more important for our purposes here, it succeeded as a social unit. People who were on the team got such a kick out of what they were doing that colleagues outside the team were positively jealous.

The black outfits and the silly exaggerated behavior were part of the fun, but there was something much more fundamental going on. The chemistry within the group had become an end in itself.

Over time, of course, members of the team moved on one at a time to other things. Since the team function was extremely important to the company, departing members were replaced immediately.

This change continued until finally there wasn't a single member left of the original group. But there was still a Black Team. The team survived the loss of all its original staff, and it emerged with its energy and its personality intact.

Thinking on the job

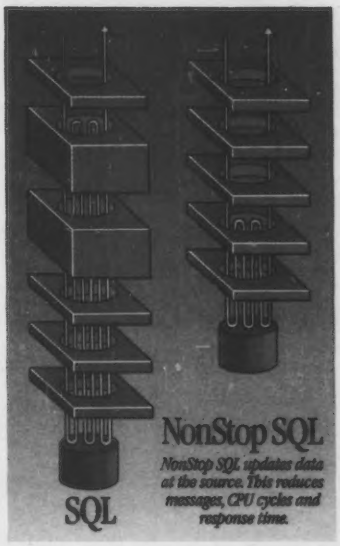
Years ago at Bell Laboratories, we worked in two-person offices. They were spacious and quiet, and the phone calls could be diverted. I shared my office with Wendl Thomis, who went on to build a small empire as an electronic toy maker.

In those days, Thomis was working on the ESS fault dictionary. The dictionary scheme relied on the notion of n-space proximity — a concept that was hairy enough to challenge even Wendl's considerable powers of concentration.

One afternoon, Thomis was staring into space, his feet propped up on the desk. The boss came in and asked, "Wendl! What are you doing?" Wendl said, "I'm thinking." The boss said, "Can't you do that at home?"

The difference between that Bell Labs environment and a typical modern-day office plan is that in those quiet offices, one at least had the option of thinking on the job. In most of the office space we encounter today, there is enough noise and interruption to make any serious thinking virtually impossible.

More's the shame: Your people bring their brains with them every morning. They could put them to work for you at no additional cost if only there were a small measure of peace and quiet in the workplace.



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Beyond productivity

By John Barnes

The great British economist, John Maynard Keynes, once pointed out that "practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist."

He meant, of course, that ideas have a way of making their way out of the realm of theory and into the real world — usually shaking off a lot of the warnings, caveats and provisos that were once attached to them.

Productivity was originally an economist's idea, sort of an equivalent to the engineer's idea of efficiency: desired output divided by scarce or costly input. Around 1900, the first generation of managers to have gone to college and taken economics brought the idea into the business world.

It didn't take very long for the general idea of productivity, which had been applied to any input, to get focused on the one input that was usually the bottleneck: labor.

In the context of the assembly line, the billing office or the complaint-handling department, productivity made a lot of sense. How many gadgets got built, or bills sent, or complaints resolved, per person-hour? Push the number up and the company made more money; let it sink and the company lost money.

But ideas are tools, as Keynes said, and productivity isn't the only tool in the box.

For example, modern Japanese auto plants, with their extensive robotization, certainly have much higher productivity than the hand-manufacturing setups at Rolls-Royce or Ferrari — but which would you rather own, a Rolls or a Honda Civic?

Form and function

Go to any anthropological museum and one of the first things you notice is how many things — cooking pots, tools, clothing — are carefully, painstakingly decorated. Anthropologists often observe that it took more time to decorate the object than to make it, and of course there is no material gain from the decoration. An undecorated shovel digs as well as a beautifully adorned one.

From a pure productivity standpoint, all that extra labor is an absurd waste. Yet we "practical" modern people live surrounded by ugly-but-functional things, and our "primitive" counterparts surrounded themselves with art that we think good enough to put in museums.

WARREN GEBERT

Everyone complains of the lack of craftsmanship in present-day goods, yet obviously the less work that goes into any one unit, the more of them can be made in a given time. Higher productivity and lower craftsmanship go together perfectly.

However, productivity is only one of many good things in the world, and we don't figure success only in terms of productivity any more than we try to subsist entirely on ice cream. In fact, if you check back into the economic background of the concept, productivity used to be called "productivity with quality held constant."

What if we put the idea of quality back into it? For generations, economists and businessmen have treated quality as something you can point to but not define or measure. Quality was something that a product acquired when someone with a lot of skill put a lot of time into it. But knowing how you got it didn't mean you knew what it was.

Perhaps the information industry can now supply an answer. I suggest that the quality of a product is directly related to the amount of information that goes into it. The skills of the builder, the design of the plan, the rigor of the concept — these are all measures of information.

And that, I think, is where your impact will finally be most revolutionary: Not in productivity itself — though that is important, and great gains have been made in that area — but in the creation of the first high-productivity, high-quality economic system.

Primitive systems are low in productivity, but because labor is almost free, they tend to be high in quality.

The modern system has traded shoes that fit perfectly for ones that almost fit, individual design and tailoring for mass production of clothing in a few colors and sizes, and tools that fit your hand for tools that fit that mythical "average" person's hand. In short, the policy has been that everything has been dramatically lowered in quality so that it can be cheaper and more plentiful. Productivity has soared while quality has plunged.

In the next 10 to 50 years, that relationship will reverse. Desktop publishing will make it possible for every designer of almost any product to put out a catalog. Computer-aided design will allow any design to be modified to meet individual needs and tastes.

And — most important of all — computer-aided manufacturing systems will allow a manufacturer to change specifications for every individual unit made, if need be. Thus, it will cost no more to make units for each individual than to make a one-size-fits-all product; the issue of decision for the buyer will be much less one of price and much more one of quality.

One size fits all?

Consider: Your forearm is probably not the same length as the forearm of the person who sits next to you. Yet if both of you go to the hardware store to buy hammers, chances are you will get identical ones.

Further, for every forearm length, there is a right place for the balance point on a tool — a place that maximizes applied force and minimizes elbow strain. It is very unlikely that an off-the-shelf hammer will fit your arm properly — and flatly impossible that it will fit both you and your neighbor.

For most of your life, you have been voting with your dollars in the market for higher productivity at the expense of lower quality. You accepted a little more damage to your elbow so that the hammer would be cheaper.

But it could be different — it is going to be different in the future. You will go to the hardware store — or perhaps to a sort of generic "fitting store" — and pick out a basic design, perhaps asking generally for a claw hammer, but potentially specifying any combination of head and shaft materials in any shape.

A technician will carefully measure your arm and take down your credit card number. You'll go home, and a few days later, the right hammer will arrive by parcel post or UPS.

It's even possible that the hammer will get there before the bill does.

Barnes is the Pacific Northwest area manager for ADG, a high-tech marketing organization based in San Pedro, Calif. His second novel is *Sin of Origin*, published by Congdon & Weed.

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   - 35. Dir., Mgr., Suprv., OA/WP
   - 38. Data Comm. Network/Systems Mgt.

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The architecture is expected to evolve during the next couple of years, AT&T said. The company intends to publish initial NMP specifications within the next few months.
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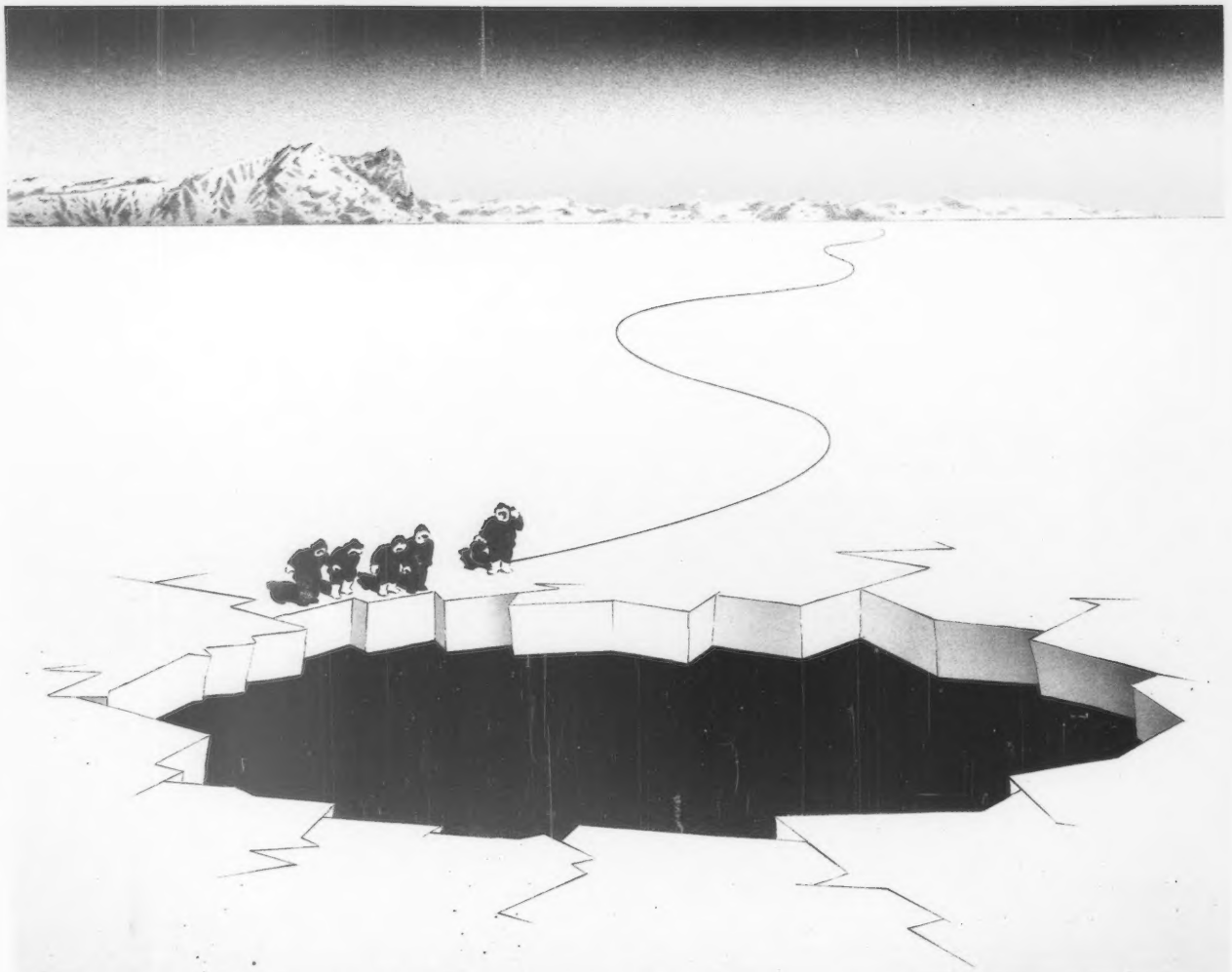

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